Cosmogenic ^{36}Cl dating of the Granite Canyon moraine complex in the Teton Range to determine fault offset rates and the influence of valley hypsometry on glacier behavior

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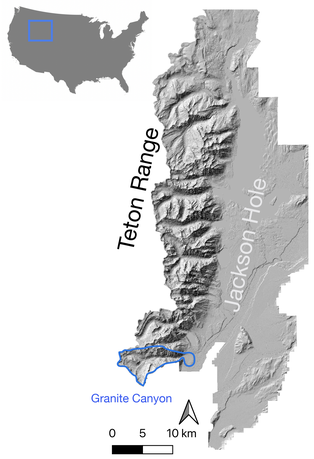
Introduction

- Chronologies of terminal moraines have been developed for most major western U.S. mountain ranges that hosted alpine glaciers during the Quaternary (Laabs et al., 2020)
- The influence of valley gradient and glacier hypsometry on glacier behavior remain incompletely understood
- Exposure ages combined with geological and glaciological analyses offer insight into the non-climatic factors that influence glacier response to climate shifts (Licciardi and Pierce, 2018) and offer an opportunity to reconstruct past tectonic activity along the Teton Fault
- We use ^{10}Be and ^{36}Cl exposure dating on the latero-terminal moraine complex at Granite Canyon to determine the timing of glacial retreat, examine non-climatic influences on glacier behavior, and calculate offset rates for the Teton Fault since deglaciation

Why Granite Canyon?

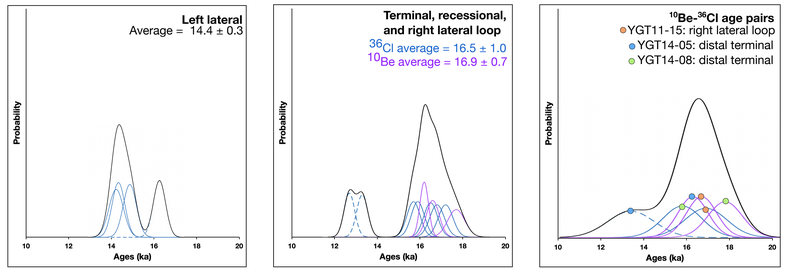
- Granite Canyon exhibits a contrasting bedrock lithology, valley hypsometry, and moraine morphology relative to other glaciated valleys in the eastern Teton Range
- Dating of the lateral moraines where they are cross-cut and offset by the Teton Fault offers an opportunity to calculate offset rates for the southern end of the fault (Thackray and Staley, 2017; DuRoss et al., 2020)



Methodology

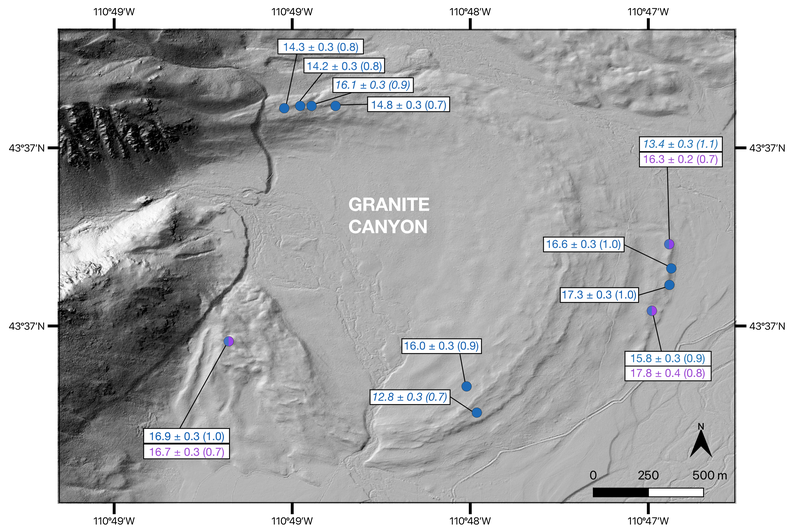
- Obtain ^{36}Cl and ^{10}Be exposure ages for the Granite Canyon latero-terminal moraine complex
- Characterize the Granite Canyon valley and paleoglacier hypsometry and moraine morphology relative to adjacent valleys in the Teton Range
- Calculate vertical separation of fault scarps on the Granite Canyon lateral moraines and determine cumulative offset rates for the Teton Fault since deglaciation

Granite Canyon Glacier



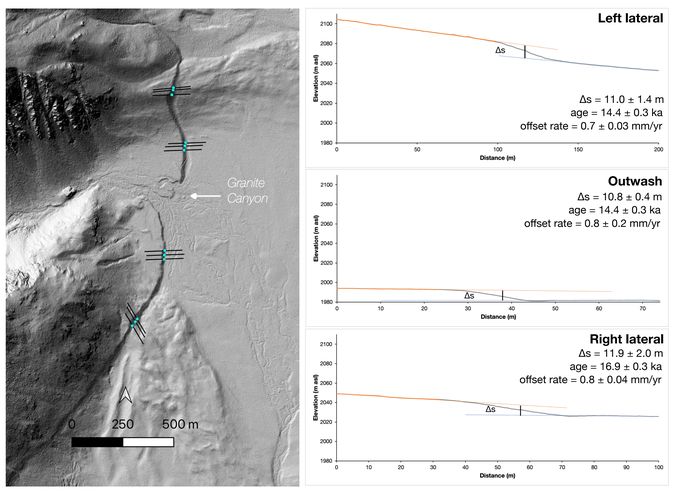
Normal kernel density plots of ^{36}Cl and ^{10}Be exposure ages of boulders on moraine crests. Purple,^{10}Be; blue, ^{36}Cl; dashed line, outliers not included in average. First two panels use internal uncertainty; splits use external uncertainty.

- Exposure ages from Granite Canyon suggest that the piedmont lobe began retreating from the right lateral loop and terminal crests ~16–17 ka, after the end of the global LGM
- In contrast to valleys further north, the left lateral moraine deglaciated later than the terminal, recessional, and right lateral loop
- Preliminary results indicate that the Granite Canyon glacier produced a terminal moraine complex that was on average half the volume of the complexes at valleys further north



Summary of ^{36}Cl and ^{10}Be ages from the Granite Canyon latero-terminal moraine complex. ^{36}Cl ages are denoted in blue and ^{10}Be ages on splits of the samples are denoted in purple. Individual ages and uncertainties are expressed in thousands of years (ka). External uncertainties are noted in parentheses. Italicized ages are outliers. Right lateral age published in Pierce et al. (2018).

Teton Fault Offset Rates



Determination of vertical separation (Δs) and offset rates from topographic profiles across the Granite Canyon fault scarp. Left, profiles were taken from the right lateral, outwash (average of both locations), and left lateral at multiple locations to obtain a weighted average for the feature. Right, Δs and offset rates.

- Hampel et al. (2021) constrained vertical separation and offset rates to ~27 m and ~1.8 mm/yr for the central portion of the fault and ~14 m and ~0.9 mm/yr for the southern portion. Using similar methods, we calculated an average vertical separation of ~11 m and offset rates of ~0.8 mm/yr since deglaciation at Granite Canyon

Conclusions and Future Work

- The Granite Canyon glacier was at its maximum extent until ~16–17 ka
- Deglaciation of the entire latero-terminal moraine complex was complete by ~14.5 ka, which is similar timing to the rest of the Teton Range (~14–15 ka)
- Fault vertical separation and offset rates are lower in the southern portion of the Teton Range than in the central parts
- Future work will analyze valley gradient and glacier hypsometry to test the hypothesis that these influenced the expression and relative timing of moraine abandonment

Acknowledgments

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