Through financial support provided by the QRC, we began research on the landscape evolution of Haida Gwaii, Canada, driven by convergence between the Pacific and North American plates. The objective of our work was to use the technique of low temperature thermochronology to determine the magnitude of uplift following the purported onset of Pacific plate subduction since 6 Ma (Hyndman 2015). Field work was conducted for two months in the summer of 2017. As a secondary target, we reached out to individuals from the Gwaii Haanas National Park Reserve and Haida Heritage Site, Taan forestry, as well as the Geological Survey of Canada regarding lidar data for a considerable portion of the islands. Thanks to support from the QRC, our field work was successful and we are in the process of interpreting data.

In the winter and spring of 2018, apatite crystals were separated from 16 granitic bedrock samples and analyzed at the TRaIL lab at CU Boulder using the apatite Helium (aHe) low temperature thermochronology technique. aHe thermochronology provides a measure of the time over which a given sample cools between 90-50 °C, and is commonly used as a proxy for near surface crustal exhumation driven by uplift and erosion (Ehlers & Farley, 2003). This data can be modelled to determine time-temperature histories that provide constraint on the rate at which samples cooled or, assuming a geothermal gradient, the rate and magnitude of a samples exhumation.

Our aHe data shows a spatial trend with younger ages nearer to the plate boundary, consistent with plate boundary forces driving exhumation and landscape development. Taking a 30 °C geothermal gradient for Haida Gwaii, our results suggest that the archipelago has experienced less than 2 km of exhumation since 6 Ma, the purported onset of subduction. This is considerably less than predicted in models and observed in the Fiordlands of New Zealand, another instance of ocean-continent subduction initiation. Furthermore, our data does not record an increase in exhumation rate coincident with the hypothesized onset of subduction, which would be expected if subduction initiation produces uplift of the overriding plate. Given this discrepancy, we envision a few potential scenarios: local conditions could dampen the uplift signal associated with subduction initiation (Mao 2017), relative plate motion models (Demets & Merkouriev 2016) may not accurately estimate intraplate shortening in this region, or shortening is cryptic and is accommodated by diffuse deformation of the plates (Rohr, 2010).

Preliminary analysis of lidar data from Haida Gwaii provides constraint on the recent topographic evolution of the islands. The most conspicuous post-glacial topographic feature observed in lidar is a prominent marine terrace rising up to 20m above present high tide. These terraces are regionally extensive and show no spatial trend in elevation above present-day sea level. The terraces are of considerable interest to the archaeological community as they frequently preserve ~9 ka artifact assemblages (Fedje & Christensen 1999). Currently, there has been no attempt to place these terraces in a tectonic context. From personal communication (Brothers, 2018), terraces at similar elevations are found in Southeast Alaska, implying uplift or relative sea level fall is widespread. If these terraces are recording uplift, the rate is an order of magnitude higher than that recorded by thermochronology. Research is ongoing with regards to the origin of these terraces.

While there is still much work to be done, this QRC grant has seeded valuable research into the recent landscape evolution of the west coast of North America. It fostered collaboration between researchers
at the University of Washington, the Geological Survey of Canada, Occidental College, and the University of Calgary, produced data to be written into at least two publications, and provides new insight into the dynamics of incipient convergence between oceanic and continental plates.

Figure: Overview map of study area showing pertinent tectonic features. Inset shows relative plate motion over past 12 Ma (Demets & Merkouriev 2016) as well as modeling results using the software QTQt (Ghallager 2012). Characteristic time temperature paths shown for samples younger than 10 Ma vs. samples older than 10 Ma. These time temperature paths show that samples were less than 60°C, by 6 Ma and, assuming a geothermal gradient of 30 °C/km, within 2 km of the surface at this time.
Samples were collected primarily by boat due to the incredibly remote nature of the islands.
Samples taken at elevation provide constraint on the erosion history of the islands.