Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.23698

Landform-scale glacial erosion during the Holocene using in situ cosmogenic ^{10}Be and ^{14}C in southeastern Alaska

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Bedrock erosion by glaciers shapes alpine landscapes and provides abundant fresh mineral surface area for chemical weathering reactions. Glacial erosion is characterized by two dominant processes: abrasion by which rock fragments entrained in basal ice are dragged over the underlying bed and gouge away material, and quarrying by which pieces of bedrock (up to multiple meters in diameter) are removed via fracture growth and then entrained in ice. Despite the importance of glacial erosion as a landscape evolution process, quantifying rates and spatial patterns of glacial erosion has remained enigmatic. Recent laboratory and numerical modeling work has advanced the mechanistic understanding of abrasion and quarrying, but relatively little work has explored how erosion rates vary at the field scale. Such constraints can further improve understanding of the dominant controls on glacial erosion, including deducing the importance of effective pressure, slip velocity, and substrate characteristics (bedrock hardness and fracture spacing) on erosion rates.

Here, we apply paired cosmogenic nuclide measurements of ^{10}Be and ^{14}C to measure glacial erosion rates at a glacially-sculpted bedrock landform near the Juneau Icefield, southeastern Alaska. The landform (a ~100 m long roche moutonnée) has an upstream side characterized by abrasion (polished and striated surfaces) and a downstream side characterized by quarrying (plucked surfaces, limited striations). We collected seven bedrock surface samples, spanning the longitudinal axis of the roche moutonnée, to measure the relative efficiency of abrasion and quarrying. Additionally, we drilled two bedrock cores ~2 m in length to improve our understanding of surface erosion rates and to better constrain the local Holocene ice margin history at this location. In order to accurately quantify erosion rates, we apply a Monte Carlo randomization of ice exposure/burial scenarios coupled to nuclide accumulation forward models. While surface bedrock samples have become a growing tool for estimating erosion rates, measurements of the ^{14}C/^{10}Be ratio with depth in shallow bedrock cores improve estimates by improving constraints on muogenic production at depth. This work will estimate the erosional efficiency of abrasion compared to quarrying, which has few direct field-based observations. At the meeting we will present our forthcoming measurements and modeling results.