Glaciers globally have been in retreat since the Last Glacial Maximum, and the timing of deglacialation in Alaska has not yet been fully understood. Surface exposure studies have been done in Alaska to understand the history of the glaciation. It was expected that glaciers at lower latitudes would have deglaciated first. Surface exposure ages from previous studies throughout the state were spatially compared to determine the timing of deglaciation. Results show higher latitude regions of Alaska deglaciating ~20 ka, and lower regions ~17 ka with fluctuations of advancing and retreat in the southern regions. Glaciers in Alaska were likely responding to changes in atmospheric circulation due to other continental ice sheet retreats. The timing of deglaciation in Alaska was different throughout the state with each region deglaciating at different times.

Abstract

The Timing of Deglaciation in Alaska Since the Last Glacial Maximum

Natalie Johansen  | Department of Geosciences  | Pacific Lutheran University  | Mentor Dr. Claire Todd

Introduction

- The Last Glacial Maximum (LGM) occurred approximately 20,000 years ago - which is the most recent time of maximum glacial extent (Briner et al., 2017). Ice sheets in North America included the Laurentide and Cordilleran ice sheets. Since the LGM, glaciers globally have been in retreat which leaves behind landforms and glacial material that can act as a record to determine the glaciation history (Booth, 1987).
- Important interstadials/stadials for glaciers include the Older Dryas (14.5-14.1 ka), Bolling-Allerød (14.1-12.9 ka), Younger Dryas (12.9-11.7 ka) (Fig. 3).
- The LGM is important to study because we can use it to determine how glaciers responded to climate forcing before industrialization affected our climate (Lasen et al., 2007).
- By studying the LGM, predictions about glacier response to climate change can be made for the future of existing glaciers. This is especially important for communities that rely on glaciers for hydroelectric power, fishing industries, and marine ecosystems.
- Previous studies in Alaska (Briner et al., 2017) include work that studied how the buildup of CO₂ is related to glacier retreat (Fig. 1). Briner found that glaciers in Alaska are at about 40% of their LGM lengths. Southeast Alaska is a region that is poorly understood by glaciologists as past glacial sea level rise has covered much of the evidence of the glaciation record (Briner et al., 2017).
- Surface exposure dating studies have been done in Alaska to provide dates of deglaciation throughout the area. Surface exposure dating works by cosmic rays forming nuclides such as beryllium-10 in the rocks on the surface. By quantifying the amount of nuclides in the rock, an age of when the rock was exposed can be determined. Unusual high ages for an area can be due to the sample collecting nuclides before being covered by the glacier, known as inheritance (Balco et al., 2008).
- Alaska is an important region to study glaciers due to the high number of glaciers present-day. Elevations in Alaska range from 6,190 meters to sea level and latitudes range from 54° to 71°. There are many mountain ranges in Alaska which span the large latitudinal range, making it a prime location to spatially study glaciers. Locations for this study include the Alaska Range, Brooks Range, Ahklun Mountains, and Juneau icefield. (Fig. 1)

Methods

Collection:
- Created a database in Google Sheets of surface exposure samples previously done in studies from Briner et al., 2017 and Juneau Icefield Research Program (2012, 2018).
- Database consisted of 120 samples from ten individual studies. Attributes included are location, landform type (terminal moraine, recessional moraine, erratics, bedrock), elevation, calculated surface-exposure age and error. Locations were color coded by region, which include Alaska Range, Ahklun Mountains, Brooks Range, and Juneau icefield. All data taken from Briner et al., 2017 and Juneau Icefield Research Program (2012, 2018).

Synthesis:
- To account for different ages in a location, the data were sorted by region and by age to group together similar ages to determine similarities or outliers.
- Ages were averaged in two ways, a total average and a LGM average using ages from 22-12 ka. (Table 1)
- Mapped sample site locations using Google Earth to spatially compare surface-exposure ages.
- Patterns of glacial change were tested using the database to sort samples by various attributes such as latitude, age, and elevation.

Results

- Older age in the dataset of 67.2 ka in the Alaska Range is likely due to nuclide inheritance.
- Glaciers in the Brooks Range receded before lower latitude regions, a total latitudinal difference of 11°, to the Juneau icefield. This is especially important for communities that rely on glaciers for hydroelectric power, fishing industries, and marine ecosystems.
- To better determine the timing of deglaciation throughout Alaska, more surface exposure studies should be done with more samples included.

Conclusion

- The delamination of Alaska began in the Brooks Range, with the Alaska Range and Ahklun Mountains following, and Southeast Alaska currently deglaciating.
- Glaciers in the Brooks Range receded before lower latitude regions, a total latitudinal difference of 11°, confirming glaciers at sea level are strongly impacted by changes in climate.
- To better determine the timing of deglaciation throughout Alaska, more surface exposure studies should be done with more samples included.

References