

Using satellite observations to infer crevasse ages on Umiammakku Isbræ, Greenland

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Motivation

- Crevasses are a distinct and complex ice deformity commonly found on the surface of glaciers and ice sheets.
- They allow for the entry of meltwater to the interior of a glacier, promoting further crevasse formation and accelerating glacial flow, contributing to glacial retreat and oceanfront calving [2,3].
- Historically, Umiammakku Isbræ has gone through abrupt periods of retreat and stabilization [1].
- **This preliminary study aims to estimate crevasse ages at the terminus of Umiammakku Isbræ, to better understand crevasse contribution to oceanfront calving.**

Study Site

- Umiammakku Isbræ is a heavily crevasse, marine-terminating outlet glacier situated in western Greenland (Figure 1a).
- Five newly formed crevasses are of interest; Cirq (Figure 1b), W, NW, N, and E.
- Umiammakku is on the ancestral and current lands of the Kalaallit people.

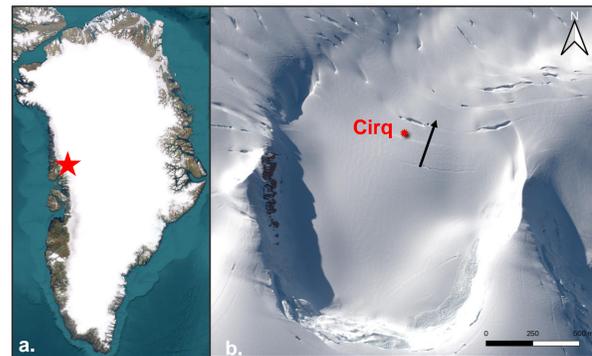


Figure 1: (a) Location of field site, red star indicates Umiammakku Isbræ. (b) World View 2 (June 2021) imagery, zoomed to Umiammakku Isbræ, Cirq crevasse, red star indicates approximate Cirq location. Black arrow indicates flow direction.

Results

- Crevasses at the terminus of Umiammakku Isbræ range in age from 293 to 500 years (Table 1) and have an average age of 340 years.
- Cirq and NW crevasses are the youngest and approach the terminus the fastest (Figure 2).
- E and W crevasses are the closest to the terminus, but W crevasse approaches the terminus the slowest.

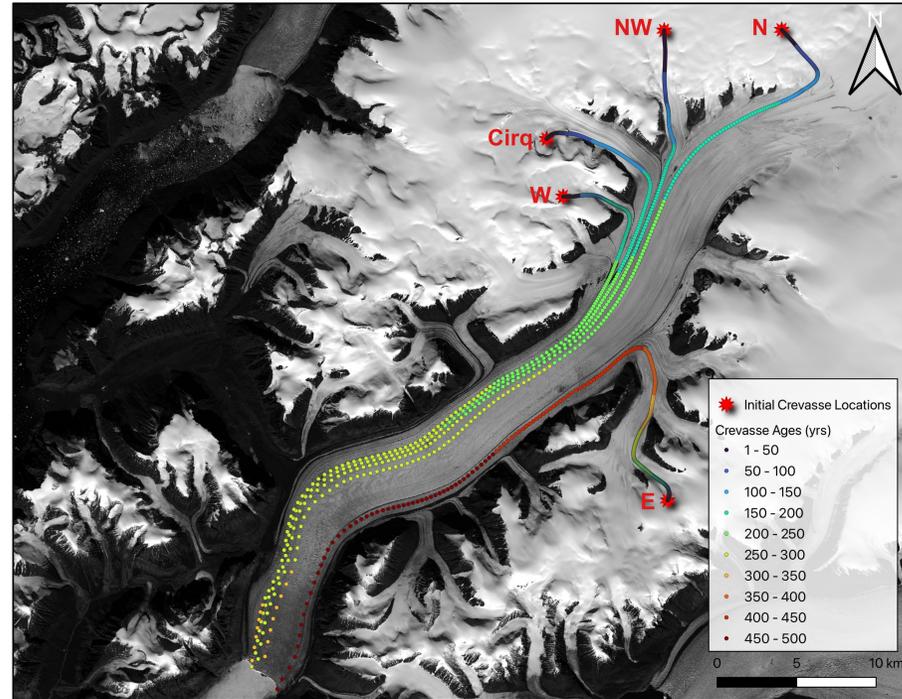


Figure 2: Map of Umiammakku Isbræ crevasses and modeled ages (colored dots). Red star indicates initial observed crevasse locations. Landsat-8 base map courtesy of the U.S. Geological Society.

Table 1: Summary of crevasses age and approximate distance to terminus.

Site Location	Terminus Age (years)	Distance to Terminus (km)
W	307	45
Cirq	293	50
NW	294	53
N	308	58
E	500	45

Methods

- Crevasse locations were assumed to be newly formed and determined using ICESat-2 ATL03 Photon Heights and Landsat-8 imagery.
- Initial crevasse coordinates were used in conjunction with NASA MEaSUREs Greenland Ice Sheet Velocity Mosaics to derive the flow path for each crevasse through time, using the following equation:

$$xy_{new} = xy_{old} + v_{xy} * \Delta t,$$

- where xy_{new} are new polar stereographic crevasse coordinates, xy_{old} are initial polar stereographic crevasse coordinates, v_{xy} are the x and y NASA MEaSUREs velocity components in $m\ yr^{-1}$, and Δt is the change in time in years.
- New crevasse coordinates were added to QGIS to develop a crevasse age map.

Conclusion

- Crevasses formed in tributary glaciers west of Umiammakku Isbræ are younger at the terminus compared to crevasses formed in eastern tributary glaciers.
- Crevasse ages are not dependent on distance from the terminus but vary on flow velocity.
- Cirq and NW crevasse approach the terminus the fastest, likely resulting in thinner crevasses compared to E crevasses, thus we can hypothesize E crevasses may have more of an influence on oceanfront calving.

Future Work

- Further analyze crevasse ages in northeastern tributary glaciers.
- Investigate the relationship between crevasse widths at Cirq and E crevasse.
- Explore the interaction between water-filled crevasses and their spatial distribution on ice velocities. What is the distribution of water-filled crevasses on Umiammakku Isbræ and how do they influence crevasse ages?

References

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