Challenging the Southern Boundary of Active Rock Glaciers in West Greenland

Rock glaciers are permafrost features, abundant in mountainous environments, and are extremely interesting as indicators of past and present climate. Evidence of an active rock glacier was observed near Nuuk, around 250 km further south than the previously suggested southern limit for active rock glaciers in western Greenland. This study aimed to determine if there are indeed active rock glaciers this far south.

Rock glaciers are characterized by a 'steadily creeping perennially frozen and ice-rich debris on non-glacierised mountain slopes'(Figure 1. They hold information on past and present climate as they i) maintain permafrost in a given climate, and ii) may contain much older ice than glacier ice (Krainer *et al.* 2015). Their runoff may contribute to local water supply in inhabited areas and thereby impact water chemistry significantly (Thies *et al.* 2007). It is therefore crucial to know about rock glaciers' occurrence and their dynamic regime.

Permafrost dynamics are key for understanding instabilities. Significant fluctuations in rock glacier movement have been shown, and are partly triggered by climate, partly by local conditions (Delaloye, Lambiel and Gärtner-roer, 2010; Nickus *et al.*, 2015). An increased dynamic variability is expected under changing climatic conditions (Delaloye *et al.*, 2013). While the area around Nuuk is acknowledged to contain sporadic permafrost (Humlum, 1982; Christiansen and Humlum, 1993), there are, to our knowledge, no studies investigating rock glaciers.

We have investigated a conspicuous rock glacier on Bjørneø. It has a clearly defined snout, distinct foliations in the central region, and notably, a lack of pioneer vegetation, all suggesting that it may be an active rock glacier.

A number of field methods were employed to determine the thermal regime, dynamic activity and climatic conditions. The thermal regime was obtained by measuring the 'Bottom Temperature of Snow' (BTS) during the winter ((Haeberli and Patzelt, 1982)). The dynamic activity was assessed based on orthophoto and derived Digital Elevation Model from repeated drone flights with a 1 year interval. The climatic conditions were recorded continually for the study period with a simple and robust temperature/air pressure sensor, installed near the snout of the potential rock glacier in order to give a first-order idea of temperature gradients between Nuuk and the rock glacier.

The BTS measurements show a clear drop in temperatures, on the order of 10 °C, over the rock glacier compared to the surrounding areas suggesting an active permafrost landform with a well demarcated thermal regime. It is noteworthy that the lowest temperatures are found in areas with the highest concentration of surface undulations, while the flatter front lobe is relatively warmer. This may support the morphological indication that a younger rock glacier is flowing over an older one. We were unable to detect any dynamic activity, but suggest that a longer time interval may give positive results.

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Data source:

GEM ClimateBasis Kobbefjord.

Photos and figures

Figure 1. Photo of the rock glacier on Bjørneø, and the island's location in the Godthåbsfjord (Photo: Dorthe Petersen).

Figure 2. Photo of 'Bottom Temperature of Snow' data collection (left) and temperature/air pressure sensor near the snout of the rock glacier (Photo: Jakob Abermann)

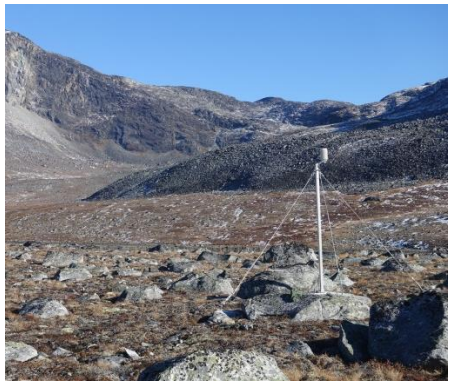

Figure 3. ‘Bottom Temperature of Snow’ results over and around the rock glacier.