Microstructures in a shear margin: Jarvis Glacier, Alaska.

Journal of Glaciology, 1-14.

https://doi.org/10.1017/jog.2021.62

Gerbi C, Mills S, Clavette R, Campbell S, Bernsen S, Clemens-Sewall D, Lee I, Hawley R, Kreutz K, and Hruby K (2021)

Abstract

Microstructures, including crystallographic fabric, within the margin of streaming ice can exert strong control on flow dynamics. To characterize a natural setting, we retrieved three cores, two of which reached bed, from the flank of Jarvis Glacier, eastern Alaska Range, Alaska. The core sites lie ~1 km downstream of the source, with abundant water present in the extracted cores and at the base of the glacier. All cores exhibit dipping layers, a combination of debris bands and bubble-free domains. Grain sizes coarsen on average approaching the lateral margin. Crystallographic orientations are more clustered and with *c*-axes closer to horizontal nearer the lateral margin. The measured fabric is sufficiently weak to induce little mechanical anisotropy, but the data suggest that despite the challenging conditions of warm ice, abundant water and a short flow distance, many aspects of the microstructure, including measurable crystallographic fabric, evolved in systematic ways.

Plain Language Summary

The investigation of three ice cores in the margin of Jarvis Glacier, two of which reached the bed, reveals that microstructural properties are more consistent within cores than between cores. Grain shape, grain size, bubble aspect ratio and crystallographic fabric all vary with proximity to the lateral margin. Grains are less circular and larger, and bubbles are more elongate nearer the margin. The *c*-axes closer to the margin are slightly more concentrated and fewer are steeply inclined. The relationship between microstructural features and rheology remains insufficiently known to establish outside uncertainty whether the observed differences in grain size, grain shape and crystallographic orientation are sufficient to account for the increased strain at JE compared to JA. The other leading factor driving increased strain is stress concentrations near the margin, which we are not able to evaluate at the present time. The study site has abundant englacial water, mean temperatures warmer than -2°C, and lies less than a kilometer from the source, all factors that impede fabric development. The fact that a measurable fabric developed in Jarvis Glacier, where conditions are unfavorable, suggests that many shear margins will develop a rheologically significant crystallographic orientation fabric.

Student Summary

What we know: The way in which glaciers flow depends on the properties of the tiny grains of snow and ice that the glacier is made of.

Why it's important: Glaciers might move either faster or slower than predicted, depending on the temperature, shape and orientation of these grains. This is extremely important if we hope to predict how glaciers and ice sheets are likely to change as the climate warms.

How the research was done: Scientists collected a series of three ice cores from a glacier in Alaska to study the properties of snow and ice grains. They specifically chose an area of complicated glacier flow in order to understand how snow and ice grains deform under different conditions.

What the evidence shows: The authors found consistent patterns in the microscopic properties of ice that may help us understand how glacier flow will change under future conditions.