Laboratory experiment of basal sliding

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Experimental procedure

In order to better understand the sliding of glacier ice over bedrock, an experimental study was carried out in a cold room with a specially designed apparatus (Fig. 1). The apparatus consists of a 100×100×200 mm chamber to hold an ice block, a 30 mm thick metal plate with rollers underneath, and two cylinders operated by an oil pump. One of the cylinders exerts normal force on the ice block which is set on the metal plate to establish the overburden pressure at glacier bed, and the other one pushes the metal plate in horizontal direction to exert basal shear stress. By keeping the ice block stationary in the chamber, a 20 mm high obstacle fixed on the plate moves in the ice, which simulates the sliding of ice over an obstacle on the bedrock.

Results

Sliding speed was measured with a displacement transducer attached to the metal plate under various temperature and stress conditions. Experiments conducted at 0 °C showed that the sliding speed was related to the basal stress with an exponent of 2.5. After the experiments, a thin section was prepared along the vertical plane in the sliding direction to examine the crystal orientations of the grains around the obstacle. Directions of the c-axes were measured at three regions: stoss side, above, and lee side of the obstacle (Fig. 2). At the stoss side, c-axes tended to align at 45° to the sliding direction within the vertical plane, while vertical single maximum was observed above the obstacle. Crystals at the lee side weakly aligned in the vertical direction.

Research plan

Relatively small exponent in the relationship between the sliding speed and the stress suggested that the creep regime was influenced by the existence of melt water (De La Chapelle and others, 1999). Crystal orientations at the stoss side of and above the obstacle were favorable to horizontal compression and horizontal shear deformation, which were strain regimes expected in each region. These results give insights into basal sliding law used for flow modelling of temperate glaciers which relates basal sliding to basal shear stress.

Reference

De La Chapelle, S., H. Milsch, O. Castelnau and P. Duval, Compressive creep of ice containing a liquid intergranular phase: rate-controlling processes in the dislocation creep regime. *Geophys. Res. Lett.* **26**(2) 251-254, 1999.

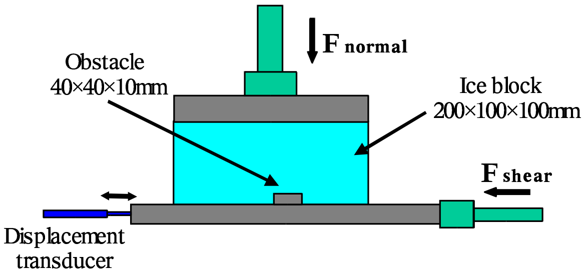

Figure 1: Apparatus used in the experiment and schematic diagram showing its function.

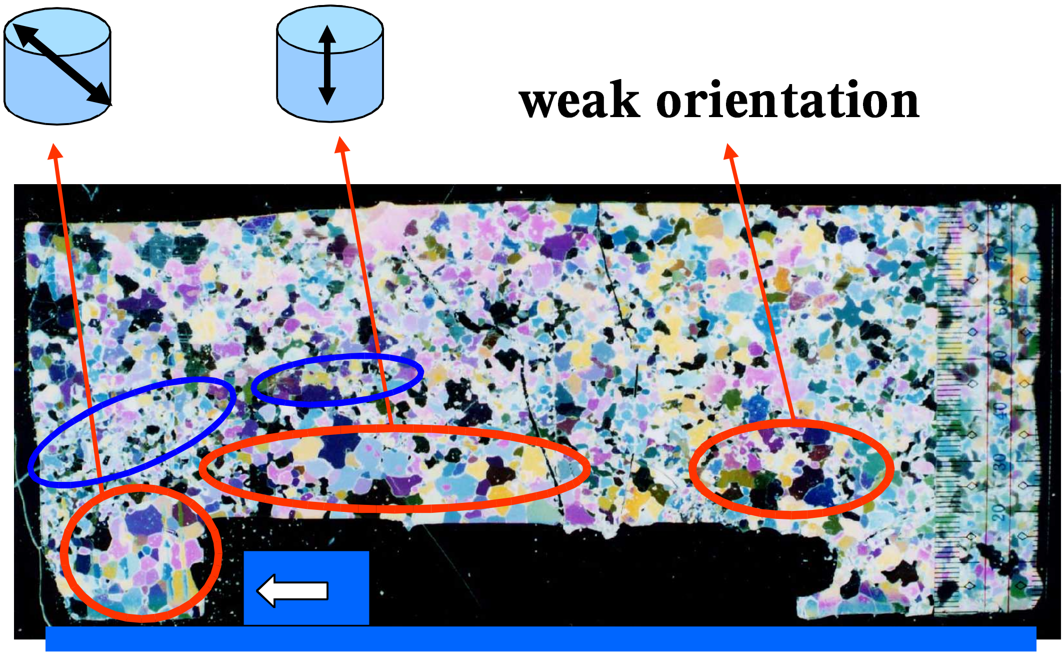

Figure 2: Pphotograph of the thin section prepared from the ice block after the experiment. Crystal orientation was measured in the three regions shown with red circles.