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Glacier dynamics during the outburst flood of a glacier dammed lake on Gornergletscher, Switzerland

S. Sugiyama (1), M. Funk (1), B. Müller (1), A. Bauder (1), U. H. Fischer (1), P. Weiss (1), M. Huss (1), N. Deichmann (2), and H. Blatter (3)

(1) Section of Glaciology, VAW, ETH, Zurich, Switzerland, (2) Institute of Geophysics, ETH, Zurich, Switzerland, (3) Institute for Atmospheric and Climate Science, ETH, Zurich, Switzerland (sugiyama@vaw.baug.ethz)

Gornersee is a glacier dammed lake which is annually formed at the confluence of Gorner- and Grenzgletscher in Wallis, Switzerland. The lake starts to be filled in spring collecting melt water and drains generally in early summer. To investigate the mechanism of the lake drainage and its impact on the glacier dynamics, we carried out field measurements in 2004. More than 20 stakes installed near the lake and down the glacier were surveyed by an automatic theodolite and GPS's with intervals of 1-3 hours. Water levels and vertical strain were measured in boreholes, and the lake level was recorded with a pressure transducer.

The lake drained from 2 to 5 July 2004 releasing approximately 4×10^6 m^3 of water. During the outburst, one of the boreholes 100 m away from the lake indicated a connection to an englacial drainage channel, while water level in another borehole 1 km downglacier rose up to nearly the flotation level suggesting subglacial connection to the drainage. Glacier surface lifted up by 0.5-3 m nearby the lake and the vertical strain could not account for the uplift. On the initiation of the outburst, ice near the lake changed flow direction towards more parallel to the main flow of the glacier, and then it reversely moved backward during the latter half of the drainage. Flow speeds at 1-2 km lower reach from the lake showed enhanced diurnal variations with twofold increase at late evening accompanied by 0.1-0.2 m surface uplift.

According to the borehole measurements and inspection of the lake after the drainage, the water drained presumably through several channels englacially and also subglacially. Although the flow speed increase and surface uplift observed downglacier

can be explained by subglacial water pressure raised by the drained water, ice movement nearby the lake is difficult to interpret. Extremely large uplift suggests fracture processes, such as cantilever movement or thrust of marginal ice at crevasses, took place. As a mechanism of the reversal in the flow direction, we propose an elastic reaction of the ice to the rapid changes in basal conditions. When the water started to drain, ice near the lake was dragged into the main flow direction of the glacier which was enhanced by high water pressure. Then, elastic component of the deformation rebounded when the drag from the main flow decreased.

These observations indicate strong impact of the lake drainage on the glacier dynamics, and also suggest that the extraordinary ice movement near the lake took an important role in the triggering mechanism of the outburst.