

Name of research institute or organization:

**Versuchsanstalt für Wasserbau, Hydrologie und Glaziologie, ETH
Zentrum**

Title of project:

Study of outburst floods of glacier-dammed lakes

Project leader and team

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Project description:

A glacier outburst flood is a sudden drainage of a glacier dammed lake. Serious damage has been caused by such events in the Alps, Iceland, Himalayas and other glaciated regions over the world. In the extreme case, the release of huge amounts of water from disintegrating ice sheets has a potential to trigger a global climate change as happened in the past. This project studies the drainage process of the Gornersee in the Valais in order to better understand the triggering mechanism of lake drainage and its impact on glacier dynamics.

The Gornersee is formed annually in spring at the confluence of Gorner- and Grenzgletscher and drains generally in early summer. During the period of formation and drainage of the lake in 2004, intensive field observations were carried out. A stake network on the glacier was surveyed by theodolite and GPS, subglacial water pressure and vertical strain were measured in boreholes, and the lake level was recorded by a pressure transducer. An automatic weather station was set up on the glacier flank, and discharge, conductivity, turbidity and water temperature were measured at the outlet stream near the glacier terminus. Seismic measurements were conducted with a network of geophones by Institut of Geophysics, ETH Zurich. Figure 1 shows the locations of some these measurements with annual flow speeds indicated by arrows obtained by the theodolite survey. Another field campaign on Gornergletscher is scheduled in spring/summer 2005.

The lake drained from 2 to 6 July 2004 releasing approximately 4 million cubic meters of water (Figs. 2). During the drainage, the water level in the 430 meter deep borehole stayed at nearly the flotation level, and then it dropped below the level before the drainage (Fig. 3b). This suggests that basal drainage became more efficient after the event as the lake drained subglacially. Surface flow speed at GPS14 showed clear diurnal peaks from 3 to 5 July (Fig. 3c) and the glacier surface lifted up about 20 cm followed by a similar amount of downward movement (Fig. 3d). These observations indicate that the glacier flow regime was significantly influenced by the lake drainage through changes in basal conditions. Another observation showing the impact of the outburst flood on the glacier dynamics is the change of the flow direction near the lake. The glacier flows southwest at GPS42 under normal condition, but it flowed northwest during the drainage (Fig. 3e). Interestingly, it flowed back southeast after the event which can be attributed to the elasticity of glacier ice. It is expected that the triggering mechanism of the outburst will be revealed by the data from the seismic experiments (not yet analysed) by detailed examinations of ice movement near the lake.

Numerical modeling commenced in Autumn 2004. Models for the whole glacier, e.g. mass balance and melt models, are created. These can then be used as basis to interpret data and as boundary conditions to model the hydraulics and dynamics of the glacier during the flood. In these aspects the VAW cooperates closely with Institut for Atmospheric and Climate Science, ETH Zurich.

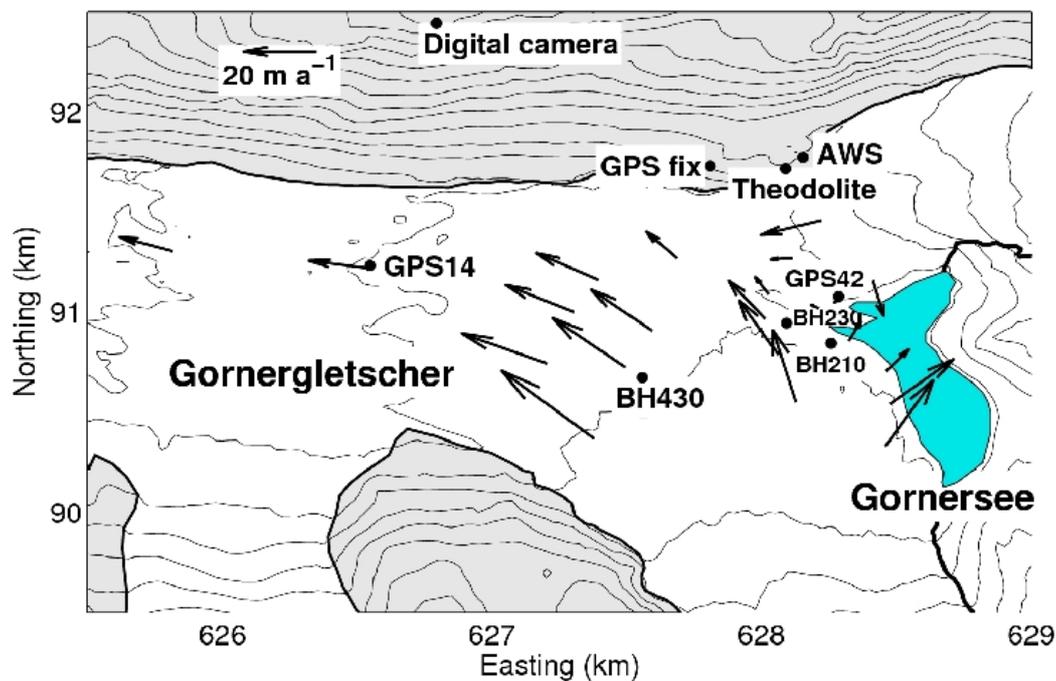


Figure 1. Locations of some of the measurement sites at Gorner- and Grenzgletscher. Surface flow speeds are indicated with arrows.

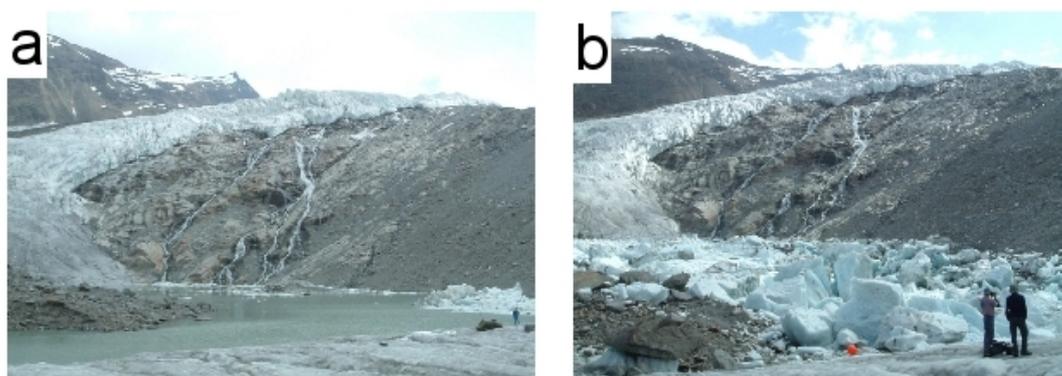


Figure 2. Gornersee seen from northeast before (01/07/2004) and after (06/07/2004) the drainage.

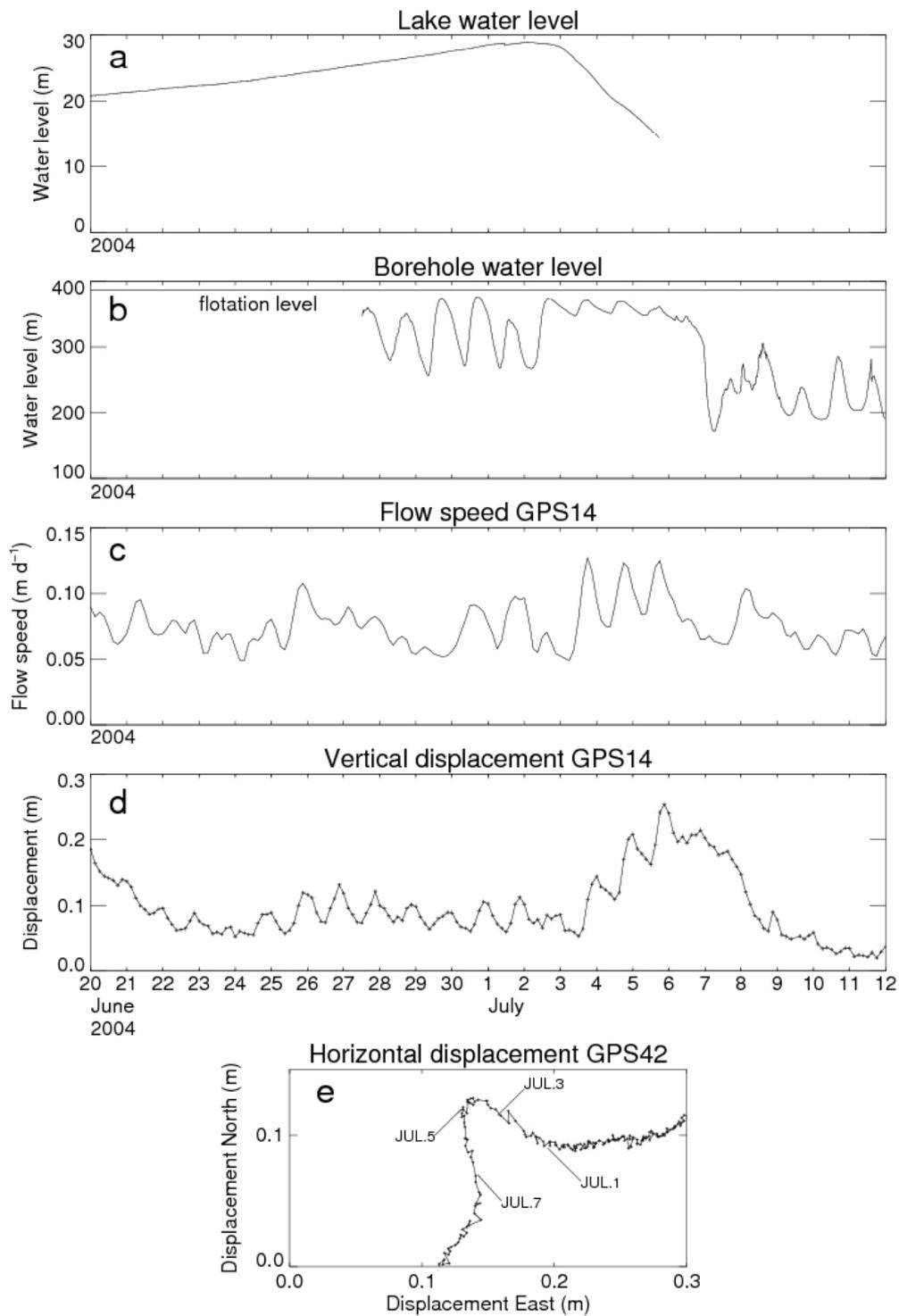


Figure 3. Water level measured in Gornersee (a) and in the borehole BH430 (b), surface flow speed (c) and vertical displacement (d) at GPS14, and displacement of glacier at GPS42 (e).

Key words:

Glacier outburst floods

Internet data bases:

www.vaw.ethz.ch/research/glaciology

Collaborating partners/networks:

Institut for Atmospheric and Climate Science, ETH Zurich
Institut of Geophysics, ETH Zurich

Scientific publications and public outreach 2004:

Data books and reports

Sugiyama S., and B. Müller, M. Funk, Outburst flood of the glacier dammed lake on Gornergletscher, Annual report 2004, VAW, ETH Zürich, 2005.

Radio and television

TV SF1, "Schweiz aktuell", July 23, 2004

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