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Evolution of a glacial drainage system throughout the melt season and due to enhanced water input

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Glacial aquifers show similarities to both karstic and fissured aquifers. Water can flow through cracks in the ice caused either by hydro or mechanical fracturing. As in a karstic aquifer these flow paths can widen with time; in the case of glaciers by melting of the ice walls due to the dissipation of potential energy. However they can also close by plastic deformation of the ice. The time scale for these processes lies in the order of days to weeks, so a glacier is a highly dynamic hydrological system.

One way of investigating the hydrology of glaciers is with the aid of tracer experiments. We conducted around 130 tracer experiments in the years 2005 and 2006 on Gorner glacier, Switzerland. The fluorescent dye was injected into moulins, which is where the surface water enters the glacier (similar to swallow holes). A selection of these experiments will be presented with the aim of showing the evolution of the drainage system on different time scales.

One series of experiments was conducted throughout the melt season and shows the evolution of the glacial drainage system from inefficient to efficient. Flow speed of the tracer increased from 0.1 m/s to 0.5 m/s whereas dispersion decreased from 20 m^2/s to 5 m^2/s.

The second series shows the evolution of a moulin. Within three days it transformed from a small (ca. 0.1 m^3/s) to a large moulin (ca. 5 m^3/s) due to the inflow of an overspilling lake. In this time span the flow speed more than doubled from 0.3 m/s to 0.65 m/s.