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Fact sheet for the now-collapsed Birchgletscher, Switzerland

SUMMARY: On Wed 28.05.2025, ~15:30 CEST, the glacier known as Birchgletscher (Valais, Switzerland), collapsed under the weight of the rock-debris that had accumulated on its surface due to a series of rock avalanches originating from Kleines Nesthorn, a mountain peak that became unstable in the course of the preceding week. This factsheet provides our present understanding of the situation, including key background information for the glacier, its pre-event behavior, the role of permafrost, possible links to climate, and information about comparable events involving glaciers in the past.

Key facts about the glacier

Name: Birchgletscher
Swiss Glacier Inventory (SGI) ID: B32-06
Location (Lon/Lat; WGS84 coordinates): 46.402542, 7.838604
Elevation range (as of 2023): from 2563 to 3430 m a.s.l.
Area (as of 2023): ~0.34 km^2 (of which about 0.14 km^2 were impacted)
Ice volume (as of 2023): ~5 million m^3 of ice (of which ca. 3 million m^3 were impacted)
Maximum ice thickness (estimated): ca. 40 m
General characteristics: The small glacier consisted of three disconnected parts. Whereas the upper two glacier sections are steep, contain little ice volume and are unrelated to the present instability, the main body of the glacier had smaller surface slopes and was mostly covered by supraglacial debris before its collapse.

Pre-event evolution

Due to two notable snow and ice avalanches in December 1993 and December 1999, which had a partial impact on the local infrastructure, the upper part of Birchgletscher has been under observation over the past decades. Since about 2019, the front of the lower part of the glacier advanced by approximately 50 meters related to an acceleration of ice flow (https://www.planet.com/stories/birchgletscher-_aQhOXzNg). At the same time, ice thickness at the glacier snout increased by up to 15 meters between 2017 and 2023, while the glacier dynamically thinned in the upper reaches. This unusual behavior was possibly due to the accumulation of rock debris that originated from periodic, pre-event rockfalls. While not adding significant mass to the glacier, this debris insulated the glacier ice, thus reducing melting rates. These changes of Birchgletscher, diverging from all other Swiss glaciers, were known to authorities and were thus monitored regularly.

Present understanding of the event on 28.05.2025

While detailed investigations will need to follow, the main drivers of the event on 28.05.2025 appear to be (i) the terrain motion caused by the partial collapse of Kleines Nesthorn, a formerly 3335 m a.s.l. high mountain peak located above the glacier, and (ii) the accumulation of a large quantity of rock debris, originating from a series of medium- to large-sized rock avalanches stemming from Kleines Nesthorn.

The weight of these accumulated materials must have resulted in the following effects on the ice although the relative role in triggering the failure still remain uncertain: (1) A strong increase in pressure on the ice, which – in a temperate glacier – leads to more pressure melting and thus both basal and englacial water production, estimated to be in the order of 10 mm and occurring directly after the deposition of the rock mass. (2) The observed acceleration of ice flow after the deposition of the rock mass (estimated at up to 10 m/day), which resulted in high shear heating and represented an estimated additional water input at the glacier base of ca. 5 mm/day. (3) The onset of snow melting and a minor rainfall immediately before the failure, contributing to additional water to the system. (4) A strong increase in basal shear stress due to additional loading of the glacier and approaching the limit which the glacier bed can support.

Combined, these factors likely resulted in a rapid rise of englacial water pressure and, thus, reduced basal friction, as indicated by the acceleration of the ice flow before the failure. This eventually destabilized the entire lower and thicker part of the glacier (estimated at 3 million m^3 of ice), and caused a catastrophic rock-ice avalanche burying the village of Blatten. With an estimated rock debris that accumulated on the glacier surface in the order of 3 million m^3 (or ca. 9 million tons) and the mobilized glacier volume, the rock-ice avalanche released a large amount of potential energy over the elevation difference of 1,000 meters. This energy would be sufficient to melt several 100,000 tons of ice, and might have resulted in the melting of around 10% of the involved ice volume. The resulting rock-debris and ice mixture led to the damming of the river Lonza, which flows in the valley below the glacier.

The situation of the glacier before and after the collapse is illustrated by Rapid mapping acquired by the Federal Office of Topography swisstopo (https://s.geo.admin.ch/y1o40mtw055l). This indicates that the entire lower section of Birchgletscher has disappeared (0.14 km^2).

Bedrock of Birchgletscher after the glacier detachment. Photo: 01 June 2025, D. Farinotti

Role of permafrost and impact of climate change

The area of the rock instability at Kleines Nesthorn that initially triggered the Birchgletscher collapse lies within a zone of probable permafrost, as indicated by the map of potential permafrost distribution (https://s.geo.admin.ch/6nbb4ccmkp08) by the Federal Office for the Environment. Permafrost, is known to degrade under global warming, potentially leading to increased permeability of rock slopes. Stronger water infiltrations can have a destabilizing effect on rock slopes. A direct causal link between permafrost degradation and the specific collapse event is not possible at present, establishing a direct link between this individual event and climate change is thus difficult. However, and as a matter of fact, rising global temperatures are leading to drastic changes in high mountain areas, resulting in a higher availability of meltwater from both snow and ice, and more rain rather than snow at high elevations. These changes can all negatively affect the stability of permafrost-affected rock faces both in the short- and medium term.

Deposition in the valley floor. Photo: 01 June 2025, D. Farinotti

Comparison to other historical events

At the scale of the Swiss Alps, the recent event is unprecedented. This is true for both the dynamics and the impact of the rock-ice avalanche. However, some parallels exist to other known events in both Switzerland and globally:

- There are some similarities to the 2017 event at Pizzo Cengalo (Grisons, Switzerland), where ~3 million m^3 of rock impacted a small glacier below, partially entraining it and forming a highly mobile debris flow that caused damage in the downstream village of Bondo and claimed eight lives along the way.
- Notable even if different in nature, is the rock-ice collapse on 14 April 2024 at Piz Scerscen (Grisons, Switzerland), which involved an estimated volume of 8-9 million m^3 but did not cause any damage. Here, a glacier sat atop a large rock volume that failed, and the resulting mass-flow ran about 5 km out of the Roseg valley.
- Outside of Switzerland, some similarities can be seen with the much larger Kolka-Karmadon glacier collapse, which happened on 20 September 2002 in the Russian Caucasus Mountains. In that case, heavy rock and ice falls from the northern flank of the Kazbek massif deposited several million m^3 of material on the glacier surface. In response to this, the relatively flat glacier accelerated, and thus bulged and crevassed, and eventually detached completely. This caused around 130 million m^3 of ice to rapidly accelerate, travel up to 19 km downstream, and deposit a debris layer of locally over 100 meters in the valley. The ice and debris buried the village of Nizhniy Karmadon, dammed the river flowing into the Genaldon gorge, flooding additional settlements and caused at least 125 casualties.
- On an equally large scale, the detachment of Sedongpu Glacier (southeast Tibet) in October of 2018 removed around 130 million m^3 of ice. This detachment occurred after a rock avalanche of 50 million m^3 that impacted the glacier a year prior. The rock avalanche had no apparent immediate impact on the glacier, but large ponds formed on the glacier and the flow velocities increased from 1-3m per day to 25 m per day during the 9 months before the

detachment. This ultimately culminated in the complete failure of the glacier and a damming of the Yarlung Tsangpo river.

A summary of other known events with some similarity (not including the Swiss events at Pizzo Cengalo and Piz Scerscen) can be found in the following publication: https://tc.copernicus.org/articles/15/1751/2021/

Further information

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Imagery

The link below provides images and videos of Birchgletscher and the deposits at the valley floor, as taken on our field visit of 01 June 2025. Imagery may be reused when stating the source: *"VAW Glaciology - ETH Zurich & WSL Sion"*. The materials are shared with the permission of the Meldungsstab Kippel, whose work is greatly appreciated.

https://polybox.ethz.ch/index.php/s/fMz9LLwop9qiBzr