

Postprint of the Study on the ‘5.28’ High-Altitude Long-Runout Ice-Rock Avalanche-Debris Flow at Birch Tree, Swiss Alps

Authors: Zhang Shilin, Huo Zihao, Yang Chaoping, Chen Feiyu

Date: 2025-08-20T00:00:00+00:00

Abstract

On May 28, 2025, a high-altitude long-runout ice-rock avalanche-debris flow disaster occurred at the Birch Glacier in the Alpine region of Valais, southern Switzerland, resulting in the complete destruction of the downstream towns of Blatten and Ried, emergency evacuation of over 300 individuals, and one person reported missing. Based on multi-temporal satellite remote sensing imagery, pre- and post-disaster unmanned aerial vehicle (UAV) data, slide-seismic signals, and on-site video materials, this study conducted a systematic investigation into the development characteristics, evolutionary processes, and disaster-forming dynamics of the “5.28” Birch high-altitude ice-rock avalanche-debris flow disaster. Preliminary results indicate that, driven by the combined effects of global climate warming and freeze-thaw cycles, Nesthorn Peak, located on the southern side of the upper Birch Glacier with a relative elevation difference of approximately 300 m, frequently experienced rockfalls. The fallen debris continuously accumulated on the glacier surface, which not only weakened glacier ablation but also enhanced the plastic flow of the glacier, leading to intensified frontal bulging deformation and expansion of ice crevasses. Remote sensing interpretation reveals that over the past decade, the glacier area has expanded by approximately 44%, and the glacier tongue has advanced by approximately 110 m. During the disaster event, approximately 3 million m³ of wedge-shaped collapse mass experienced high-altitude instability, continuously impacting and loading the lower Birch Glacier at a velocity of approximately 36 m/s, triggering the overall instability of approximately 6 million m³ of glacier and its overlying debris. This subsequently transformed into a high-speed, long-runout ice-rock debris flow that exited the gully mouth at an average velocity of approximately 64 m/s, before coming to rest after colliding with the opposite mountain slope. This type of ice-rock high-altitude long-runout geological hazard, developed in high-cold, high-altitude extreme alpine regions, is widely distributed in the Himalayan orogenic belt of China, posing a serious threat to the geological safety

of major engineering projects. This research can provide certain references for relevant disaster prevention and mitigation efforts.

Full Text

Preamble

Title: Study on the May 28 Birch High-altitude and Long-runout Ice-Rock Avalanche in the Swiss Alps

Authors: ZHANG Shi-lin², HUO Zi-hao¹, YANG Chao-ping¹, CHEN Fei-yu²

Affiliations: ¹ China Institute of Geo-Environment Monitoring, Technical Guidance Center for Geological Disaster Prevention, Ministry of Natural Resources, Beijing 100081, China

² Faculty of Geosciences and Engineering, Southwest Jiaotong University, Chengdu, Sichuan 610031, China

Abstract

On May 28, 2025, a high-altitude, long-runout ice-rock avalanche-debris flow disaster occurred at the Birch Glacier in the Valais Alps of southern Switzerland. The event completely destroyed the downstream towns of Blatten and Ried, forced the emergency evacuation of over 300 residents, and left one person missing. Based on multi-temporal satellite remote sensing imagery, pre- and post-disaster UAV data, seismic signals, and on-site video footage, this study systematically investigates the development characteristics, evolutionary processes, and disaster-forming dynamics of the May 28 Birch high-altitude ice-rock avalanche-debris flow.

Preliminary results indicate that driven by the combined effects of global warming and freeze-thaw cycles, Nesthorn Peak—located on the southern side of the upper Birch Glacier with a relative elevation difference of approximately 300 m—has experienced frequent rockfalls. The fallen debris continuously accumulated on the glacier surface, which not only reduced glacial ablation but also enhanced the glacier's plastic flow, leading to intensified frontal bulging deformation and crevasse expansion. Remote sensing interpretation reveals that over the past decade, the glacier area has expanded by approximately 44%, and the glacier tongue has advanced by about 110 m.

During the disaster event, approximately 3 million m³ of wedge-shaped collapse mass experienced high-altitude instability, continuously impacting and loading the lower Birch Glacier at a velocity of approximately 36 m/s. This triggered the overall instability of approximately 6 million m³ of glacier ice and overlying debris, which subsequently transformed into a high-velocity, long-runout ice-rock debris flow. The flow exited the gully mouth at an average speed of

approximately 64 m/s before colliding with the opposite mountain slope and depositing in place.

Such high-altitude, long-runout ice-rock geological hazards, which develop in high-cold, high-altitude ultra-high mountain regions, are widely distributed throughout the Himalayan orogenic belt in China, posing a serious threat to the geological safety of major engineering projects. This research can provide valuable reference for related disaster prevention and mitigation efforts.

Keywords: Birch Glacier; glacial fracture; high-altitude long-runout ice-rock avalanche-debris flow

Note: Figure translations are in progress. See original paper for figures.

Source: ChinaXiv –Machine translation. Verify with original.