Geophysical and geomatic recent surveys at Whymper hanging Glacier (Aosta Valley – Italy)

Fabrizio Troilo¹, Simone Gottardelli¹, Daniele Giordan², Niccolò Dematteis², Alberto Godio³, and Christian Vincent⁴

¹Mountain Safety Foundation, Glaciers and Permafrost Office, Courmayeur, Italy (ftroilo@fondms.org)
²CNR - Italian Research Council - IRPI department, Torino, Italy
³Politecnico di Torino, DIATI - Dipartimento di Ingegneria dell'Ambiente, del Territorio e delle Infrastrutture, Torino, Italy
⁴IGE (Institut des Géosciences de l'Environnement), Grenoble, France

The Grandes Jorasses Massif culminates at 4203m at the Punta Walker summit on the border between France and Italy. The south slope of Grandes Jorasses is widely glaciated and overlies a populated and highly frequented area, the Val Ferret, presenting the main infrastructure being the road in the valley bottom and different hamlets the most important being Planpincieux village. Located at an altitude between 3900 and 4100 m, the Whymper Serac is a hanging glacier that undergoes periodic gravity-driven instabilities. On 1st June of 1998, 150,000m³ of ice fell, and the resulting ice avalanche reached 1750m, at a mere 400m from houses of the Le Pont village and the main Road. The monitoring activity started in 1997: a series of boreholes had been drilled to assess the basal thermal regime of the Serac and subsequently install a monitoring system for failure prediction time. Since then, no other thermal investigation was repeated.

In September 2020, three thermistor chains in three different boreholes were installed by means of hot water diesel-powered drill machine on Whymper Serac. Geophysical and topographic reconstructions at Whymper Serac are crucial for the volume estimation of possible instabilities; therefore, to assess ice thickness changes and morphological modifications, different geophysical soundings and topographical surveys were performed in 2020. The ice thicknesses were estimated employing a first airborne GPR survey on the 4th of July 2020 using a pair of orthogonal 25 MHz antennas; a second airborne GPR survey was performed using a single 40 MHz antenna on 14/12/2020. Moreover, an in-situ measure was performed through passive seismic sounding later processed as HVSR analysis to assess ice thickness estimation.

The geomatic analysis was performed by aero photogrammetric UAV surveys, and additional GCPs were materialized. The first assessment of thermal regime variation on the Serac suggests that risk scenarios, as well as monitoring possibilities, are rapidly evolving. According to these findings, bigger volumes could be involved in the destabilization of the Serac, and the evolution of the Serac from cold-based to polythermal poses a big challenge in the monitoring of deformations for the possibility of time prediction of failures. Therefore, experimentation of a long-range GB-InSAR surface deformations measures has begun to implement the existing monitoring network based
on a robotized total station with reflective prisms used on the Serac. The installation of more thermistor chains is planned for summer 2021, to validate the previous results. Ground-based GPR soundings and more HVSR seismic measurements have as well been planned for 2021 for the more robust reconstruction of the bedrock geometry.