State and evolution of the Bérard rock glacier (Southern French Alps) after its collapse in 2006: insights from geophysical, geodetic and thermal datasets

J.-M. Krysiecki1, O. Le Roux2,3, X. Bodin4, P. Schoeneich1

Introduction

In the French Alps, the summer 2006 has been marked by the sudden collapse of the Bérard rock glacier, a rare event, exceptional by the quasi complete destabilization of the landform. The objectives of our study are to analyse the present state of the Bérard rock glacier (collapse and non-collapsed mass) and its evolution after the major movements of summer 2006 that mobilized 1.5 millions m³ of material. In this purpose, electrical resistivity and seismic refraction tomographies were carried out in summer 2007, GPS survey of 40 points was initiated in summer 2007 and a thermal monitoring, composed of 6 miniature temperature dataloggers and an automatic weather station was installed on the site on summer 2007.

Thermal and geodetic data

The combination of the thermal and geodetic data allows us to distinguish three areas: A) the collapsed mass, characterized by strong morphological changes (rapid downwasting of ice/debris packets) just after the deposition but no visible signs of evolution since 2007 and which displays surface velocity below 0.1 m/yr and WEqT around 0°C; B) the highly unstable but non-collapsed median part, characterized by destabilization signs like... surface velocity between 0.1 and 4.5 m/yr and WEqT (Winter Equilibrium Temperature) values < - 2°C in 2008 and 2009.

Geophysical datasets

The electrical resistivity tomographies confirmed partly the observations made on open cuts just after the collapse, but don't reveal the 1-2-m thick layer of quasi... indicate a seismic interface on average at 3-4 m depth and mean velocity Vp of the ice-rich level around 1800-2000 m/s.

Discussion

The collapse of the Bérard rock glacier in 2006 may be representative of the consequences of mountain permafrost degradation under warming climate. Nevertheless, a first assessment of the possible triggering chain of factors (climatic conditions of the last decades, meteorological events - storms and heavy rains – during summer 2006, geological and topographic contexts) shows the high complexity of such events and the further need to study and monitor mountain permafrost, especially in populated regions where its degradation may generate hazardous situations.

Concerning the rock glacier evolution, DGPS surveys highlight a general decrease of velocities in the part B) and seasonal variation in the general movement - the rock glacier creep faster during the summer.