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Evolution of cryo-conditioned landforms since the Little Ice Age and implications on permafrost degradation: a case study from the Lac Rouge rockglacier (Clarée Valley, Southern French Alps)

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In high mountain environments, the cryosphere (both glaciers and permafrost) is increasingly affected by climate change. If the retreat of glaciers since the Little Ice Age is clearly visible and well-documented, permafrost and more particularly rock-glacier evolution is more difficult to assess. Evolution of rock glaciers is governed by factors partly known (permafrost occurrence, topographic slope, debris supply) but despite this general knowledge and global laws, the influence of local parameters (i.e. geological and topoclimatic controls) on rockglacier evolution remain not enough documented, while, it is necessary to generalize the dynamics of such a complex geomorphic system.

In this work our goal is to specify what are the signs of degradation of the cryosphere and what are the rythms and temporalities at which this degradation occurs in various topoclimatic and geological settings. In order to document how a combination of local parameters may lead to distinct responses of cryo-conditionned landforms to global warming, our work was conducted in a various (lithology, topoclimate, supply debris and snow, etc.) physical environment. We focus here on the Lac Rouge rockglacier (Clarée valley, southern French Alps) which is representative of how local settings (topoclimate, debris supply, etc.) may affect the evolution of a rockglacier. Here, a complex (i.e. combination of many sub-units) 0.15 km^2 rockglacier has developed. This rockglacier can be subdivided into two main bodies located at similar altitudes (both roots and fronts) but made of boulders of distinct lithologies and sizes, these bodies also differ in the type of ice and the topoclimate (mostly incoming solar radiation). Our study aims at comparing the evolution of these two units to document the cryosphere evolution pattern. More precisely, three objectives are defined (i) specifying the morphological changes since the end of the LIA, (ii) characterizing the evolution of glaciated areas since the end of LIA, (iii) detecting the type and the volume of ice. Consequently, the symptoms of degradation will be identified, and their spatial distribution (altitude, orientation) explained. Geomorphological field mapping, multi-temporal aerial photographs analysis and electrical tomographies are applied to reach these objectives.