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# Seismic monitoring of the Gugla rock glacier: observations and modeling of internal processes

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As a common occurrence of permafrost in alpine regions, rock glaciers are sensitive to environmental forcings and can induce slope stability issues. Global destabilizations and catastrophic collapses can occur through the warming of perennial frozen materials. Located in Wallis (Switzerland), the Gugla rock glacier is encountering a severe destabilization phase since the middle of the years 2000, with a rapid increase of its surface displacement rate (1). Rock glaciers kinematics is usually monitored by common instrumentation related to its surface (GPS, photogrammetry, satellites). But even now its internal dynamics is difficult to decipher because neither boreholes nor inclinometers provide long and accurate data (2).

However, passive seismic recordings allow a better understanding of subsurface processes, through a continuous monitoring of mechanical and structural properties inside the surveyed medium (3). By using ambient seismic noise, this methodology estimates seismic wave velocities between sensors. Since these values are directly related to the rigidity and the density of the subsurface, this method can be applied on rock glaciers to better understand internal processes.

In this view, the Gugla rock glacier has been surveyed since October 2015 with a seismological network, with the aim of estimating seismic velocity changes and detecting micro-seismicity. We use ambient noise correlations to compute daily changes in surface waves velocity. We clearly observe seasonal variations during the whole period of three years. Seismic velocities are higher in winter than in summer, likely due to a global rigidity increase within the medium during cold periods. During melting periods, we observe a sudden seismic velocity drop and a decorrelation of the seismic responses. We explain these results by a density increase due to melting water percolation into the active layer. From these seismic data, we are also able to detect micro-seismicity and extract seismic activity (micro-quakes and rockfalls). Daily frequency of these events follows seasonal variations as well, with a maximum in spring and summer, correlated with an acceleration of the rock glacier. Thanks to these observations combined with other (lithological, thermal, meteorological) data, passive seismology allows us to better understand and locate internal processes of this rock glacier, by combining seismic noise and micro-seismicity (4).

References

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