



## **Risk evaluation of an unstable rock slope using multi-parameter monitoring: application to the "Barre des Fècles", Nantua, France**

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The prevention of ground failures in mountainous areas – landslides and rock falls – rises severe issues as these geohazards are difficult to identify and quantify. A risk analysis is usually based on a geological and geotechnical study that includes the history of movements recorded in the area. When an identified phenomenon is impossible to stabilize and public safety or property is not fully guaranteed with a too low safety factor, risk management is usually improved by periodic single-parameter instrumental monitoring, with strategy of reinforcing to continuous monitoring should the movements accelerate.

However, the better the knowledge of the instability mechanism is, the more appropriate the risk prevention strategy through monitoring or remediation is. This need in deeper understanding and predictability capabilities can be provided by a temporary multi-parameter monitoring approach, using a modular and mobile system specifically designed for low-cost, rapid deployment and optimal recovery.

This approach is currently developed and tested by INERIS, on the Barre des Fècles, which overhangs the deeply embanked town of Nantua (France). This large and heavily-fractured rocky ridge, with an estimated total volume of 20 million cubic meters, has been monitored since 1993 by the CETE de Lyon, using a base of extra-long extensometers. The data indicate that the aperture of the ridge reaches 1.8 cm per year. However, the mechanism of detachment is complex and uncertain.

In order to better evaluate the presumed mechanism of change of this rocky ridge, a precise geologic and morphologic study of the site, comprising an outline of the monitoring history, was made in 2009. Then, an experimental multi-parameter early warning system was designed and installed on a rock column to complete the risk evaluation. This system includes microseismic, geotechnical, geodetic, and climatic measurements. After several months of monitoring, a first appraisal can be done regarding the technological constraints of such an installation and the quality and contribution of the collected data.