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Multi-method diachronic approach of the rockfalls and landslides at Mont Granier (1933 m a.s.l., Chartreuse Massif, French Alps)

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Located in the French Alps at the northeastern end of the Chartreuse Massif, the Mont Granier is a half perched syncline of alternating strata of limestone and marls, eastward tilted and very karstified. This mountain, overhanging the valley and the city of Chambéry (Savoie), is famous since the Middle Age because of the 1248 major landslide that affected its north face, which is known as one of the major historical collapse events in Europe (5 x 108 m3). The Mont Granier instability continues nowadays, with several large rocksfalls observed during the 20th Century (especially in 1953), and a recent impressive sequence of collapses and debris-flows during the winter and spring 2016, with a large media impact.
These last events induced a renewed interest for the study and the monitoring of the instability of this iconic mountain in order both to prevent risks and to increase scientific knowledge on mass-movement processes. Active slopes of Mont Granier are so becoming a reference test site for crossing and correlating various methods for observing, reconstructing and studying current and past landslides and “hazard cascades” (rockfalls are followed by debris flows remobilizing and remodeling the debris fans).

This poster, co-authored by all the scientific and institutional structures presently working in a collaborative and participatory approach (involving inhabitants), presents these different methods and their main first results:
- Detection, monitoring and quantification of the current and recent rockfalls and movements by crossing classic methods of extensometry (some previously installed in caves for decades, other using now remote sensing), coupled with innovative methods of seismic signal analysis and 3D reconstruction by photogrammetry and laser scanning (LS). Drones and auto-gyre were used for safe and complete photogrammetry data acquisition in very steep, high rock walls, compared and crossed with long range terrestrial and aerial LS surveys. Joined seismometry and photogrammetry provided accurate data about both occurrence time, volume, shape and tectonic guideline network of the successive rockfalls.
- Diachronic characterization of the present and past detachment and deposit zones, morphological changes in cliffs and slopes, as well as damages to forest, by photocomparison methods (monoplotting), 3D morphological mapping and dendromorphology. Aerial LS and drone surveys were also useful, as well as research of old textual or iconographic documents and testimonials allowing to date the past events and study their frequency.
- Diachronic study of the dynamics and processes of the debris-flows and their relationships with collapses events affecting the cliffs (“hazard cascade”).

The joined use of this set of methods involving various geoscientific fields appears to be very promising for characterizing and understanding such complex risk scenes where multiple kinds of hazards are interrelated at different time scales. This approach underpins a project of observatory of the Mont Granier landslides and associated risks, including all the actors involved in the comprehension and management of the phenomena, and considering the geoheritage dimension of this major French geosite. This observatory is also intended to disseminate the research findings across an interface accessible to general public.