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High resolution monitoring of hydrology and deformation in a unstable slope

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The Séchilienne landslide is located on the right bank of the Romanche River, South East of Grenoble (Isère, France). The active zone of the gravitational instability involves several millions of cubic meters. The geology consists in fractured hard rocks (micaschists) with double permeability and strong spatial heterogeneities. The deformation of the unstable slope is monitored by on-site extensometric gauges, inclinometers, GNSS and remotely by a terrestrial radar and a total station.

Hydro-chemio-mechanical processes controlling the reactivation of the landslide are influenced by the evolution of the landslide deformation in space and time, and the water circulation in the highly heterogeneous fractured media.

A hydrogeochemical monitoring of the unsaturated zone in the fractured hard rock has been carried out since 2010. This monitoring is supported by the French Landslide Observatory (OMIV) and consists in continuous measurements of physico-chemical parameters on two groundwater outlets (T°C, EC, flow rate) and weekly samplings of the waters for quality monitoring. Water chemistry is a good proxy to locate in time and space the origin of the infiltrated water. This tool is used to understand the complex relationships between chemical weathering, hydromechanical changes and weakening/deformation of the unstable material.

This monitoring indicates a correlation between water chemistry, rainwater infiltration and rock mass deformation highlighting the impacts of rock-water interactions on the landslide dynamics. But a distributed information over area is still needed because the heterogeneities of the slope and the few sampling points currently prevent a detailed understanding of the global mechanisms involved.

To better understand and constrain the hydrogeological and hydro-chemio-mechanical behavior of the slope, a multi-method monitoring of a flood wave infiltration has been carried out in early 2016 in order to distinguish possible signals related to significant displacements. Displacements were monitored by a GB-InSAR and a terrestrial laser scanner in order to obtain a global image of the deformation at high frequency (less than 1 hour). Repeated time-lapse geoelectrical profiles along four sections have been acquired each two hours on relevant plots which are suspected to be the main water flow paths from the surface to the depth. Water quality changes were monitored at high frequency in order to provide information on the water residence time.

This first dataset gives insight into the moving volumes of rock and fluids. Imagery geophysics identifies a signal of fluid circulation in a fracture with a fast transit. The chemical signal identifies the heterogeneous functioning of the drainage system (drain/low permeable structure) with a fast transit.