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Analysis of gravitational slope cycles by means of geophysical monitoring

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Since several years of studies on landslides, we realized the role and subtle interactions that existed between the structural complexity, masses dynamics and complex internal circulation of fluids. Thus, to gain a better understanding of the processes taking place during the evolution of an unstable slope, an observational study is necessary. In this perspective, our team currently monitors slow moving landslide zones. The aim of such a monitoring is to gain a better knowledge of the links between external forcing (meteorological, seismological) and signals going out of the slope (kinematic, vibrations, electrical resistivity). We present here two examples of instrumented landslides from several years.

The La Clapière DSL (Deep-Seated Landslide), at Saint-Etienne-de-Tinée village (Alpes Maritimes, France) is now very well known by the scientific community (volume, impact, challenges, observations...), but since 2007, the Versant Instabilities Multidisciplinary Observatory (OMIV, National Service of French Observation (SNO)) allowed the installation of permanent and autonomous (self-powered) measuring stations: GPS, meteorology, seismology, water chemistry sources. For three years now, a permanent electrical tomography line is installed at the bottom of the slope to complement the current monitoring system, and allowed a deeper understanding of the physical changes in the massif.

The sandy/clayey landslide named Pra de Julian, in the suburbs of Vence (Alpes Maritimes, France) has been instrumented from 10 years by our team. Since 2006, this unstable zone is equipped with a permanent ERT line. The daily acquisitions are now accompanied by continuous measurements from boreholes (thermometers, piezometers, tiltmeters) and pluviometry. All the data from these two sites are transmitted in near-real time to our lab.

The analysis of these large amounts of data over large time series allows observations of different dynamic regimes, as well as different response times to external factors: instantaneous, delayed, long-term variability. The purpose of this synthesis observational study is to analyze the temporal and spatial evolution of the apparent electrical resistivity, the displacement, the seismologic endogenous events, the hydrometeors variability and the links between these signals for these two study sites.

This new study explains the major role of the faults within the landslide, as well as the chronology of the water flow in the massif, inducing a delay between atmospheric solicitations and the movement itself. This allows a better understanding of the complex and uneven in time dynamic in such areas.