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Contribution of pluri-annual electrical time laps survey to the understanding of short and long term landslide dynamics

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The "Vence" landslide (0.8 million m3, south eastern France) is active since the 1970s and develops in a sandy-clay Eocene layer overlying a highly fractured and faulted Jurassic limestone. This peculiar geology explains the complex hydrology of the site which plays a key-role in the destabilization of the slope (water circulation within the sliding mass, fluid exchanges between superficial layers and deep karstic aquifer through faults). To understand fluid circulations within the unstable slope, a 4 years multi-parametric survey was set up. The survey combines Electrical Resistivity Tomography (2 daily acquisitions) and rainfall records since 2006, four boreholes monitoring groundwater levels as well as clinometers and temperature measurements since 2009.

Our first approach was to study the evolution of the mean apparent resistivity. This method does not require time-consuming inversions (especially for 4 years of data) and is not affected by accuracy problems link to the inversion process. Results show that, at short time-scale, the correlation between the rainfall rate, the piezometric elevation and the mean resistivity variations is representative of two hydrogeological answers to rainfalls events: small resistivity variations related to subsurface water infiltrations with a delay of few hours after the rain, strong resistivity variations with a delay of few days after the rain highlighting the influence of the drained limestone fault systems in the landslide water supply. Results also show the need to consider the landslide answer at longer time scale, since the amplitude of deformation is strongly dependent on the massif state prior the rainfall event (e.g. piezometric levels).

However, the complex link between apparent resistivity variations and real subsurface processes restricts a quantitative behavior characterization of the various geological units (drainage zones, weathered superficial layer…) and does not allow their location. To achieve better resolution, we propose a clustering analysis on both apparent resistivity data and inverted data based on a hierarchical clustering algorithm which construct agglomerative clusters using the correlation coefficient between the different resistivity measurements. A special attention was paid to data filtering as the method needs a good signal to noise ratio to be conclusive. We also carefully chose the strategy for the inversion of the apparent resistivities in order to best accommodate gaps in the data (representing about 20 percent of the survey duration). Without making any assumption on the local geology, we were able to locate geological units displaying different behaviors. Comparatively, the method applied to inverted data will probably allow quantifying fluids circulation within the unstable slope. This late information is of major importance to the improvement of landslide modeling and will help to forecast landslide re-activation.