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A Stacked aquifer system controlling the Vence landslide site (French Alps) revealed by hydrogeophysical surveying

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Since 2006, a temporal imagery of water circulation in a landslide was conducted by an Electrical Resistivity Tomography (ERT), rainfalls records and a piezometric survey to quantify the coupling between groundwater supply and circulation and landslide displacements recorded by tiltmetry since 2009.

This work is based on a multi-scale experimental approach applied on the "Vence" landslide (South-eastern France, Mediterranean climate) which is characterised by a sandy-clay sliding mass of Lower Eocene. It is considered as a translational landslide including $1.2\times10^6 m^3$ of material. This landslide affects an inhabited area about 250 m large by 350 m long, with an average slope of 12°/14°. The present day landslide activity is underlined by a variety of failure surfaces appearing in the landscape morphology: tension cracks, scarps, disorders affecting human activity and particularly the deviation of the "Lubiane" river at the foot of the slope.

The interpretation of the ERT profiles correlated with the field information confirm us the presence of the sliding surface towards 12 m depth i.e. at the contact between sliding sands and clays of Lower Eocene and Cretaceous calcareous formation. Moreover, ERT profiles display, under the sliding plane, vertical "pits" with low resistivity, i.e. groundwater circulation, in the calcareous formation. Their occurrences on each ERT profiles were interpreted as NW-SE fault zones, typical of the regional fault network.

After each precipitation, the piezometric level in the sandy-clay sliding aquifer increases gently (of the order of some cm in few days) except in December 2006, January 2008 and February 2009 where the water table increased around 150cm in few days accompanied with the strongest tiltmetric variations in 2009 and then fluctuated gently again after each precipitation. Thus the groundwater in the sliding aquifer comes from two different origins: (1) direct infiltration from precipitation on the aquifer explaining the gentle water table response and (2) groundwater overflowing from the deeper karstic aquifer hosted in the fissured and faulted calcareous formation. This deeper aquifer is attempted to be filled during autumnal precipitations till it overflowed around December and February (depending on precipitations) in the upper sliding aquifer. This groundwater rising will be facilitated by the occurrence of the fault zones revealed by the low resistivity "pits" on ERT profiles and thus explaining the fast increases in the water table measured in the sliding aquifer and the important tiltmetric variations.

The Vence landslide is a case study where two aquifers will evolve separately except during winter where they will communicate. At this time, the lower aquifer will overflow in the upper one so to increase quickly the piezometric level and consequently the tiltmetry triggering the paroxysm in the landslide displacement.