Contribution of multi-instrumental geophysics to determine the hydromechanical functioning of a deep-seated coastal landslide (Cirque des Graves, Normandy, France)

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Contribution of multi-instrumental geophysics to determine the hydromechanical functioning of a deep-seated coastal landslide (Cirque des Graves, Normandy, France) – EGU2019-2415

The coastline of eastern Calvados (Normandy) is affected by four large deep-seated rotational-translational landslides. These slopes instabilities took place because of the underlying lithology, composed by numerous sedimentary layers, in link with sediment in-flows due to alternating between marine and colluvial deposits.

The “Cirque des Graves” is characterized by an important size (1 km x 500 m) and numerous stakes (villas & strategic road). Variations of groundwater level in the landslide body is setting Cenomanian chalk panels in motion, sinking on Albion sands and sliding on Oolitoid clays. It is studied since the major acceleration of 1982, during which around 30 buildings were damaged [Maquaire, 1999]. Previous researches allowed to well constrain the functioning in regards to geomorphology, kinematic and lithology of the unstable area [Maquaire, 1990; Lisjak, 2012; Lisjak et al., 2013].

A more robust knowledge is needed in regards with hydrogeological functioning. Furthermore, the middle zone (with many stakes), is structurally not as well defined as the eastern extremity.

Funded by the ANR RICODRET project (ANR-16-CE01-0008), this research aims to improve this knowledge on the landslide structure and the groundwater flows, which requires the use of various geophysical methods.

Three different geophysical methods were used to understand the internal morphostructure and in-dynamics, especially in the middle zone: 1- Spontaneous Polarization (SP) to map the drainage paths, quantifying the natural electric potential (without information about the depth). From this data, we selected a profile with an interesting gradient in the middle of the landslide, for further analysis.

Seismic reflection investigations to complete the acquaintances thanks to waves propagation to the bedrock.

- Electrical Resistivity Tomography (ERT), for giving information on shallow structures, lateral edges and water saturation. SP was conducted in the upstream-downstream profile, in order to confirm the hypothesis of functioning and define the boundary conditions of the middle zone thanks to both ERT/seismic surveys.

REFERENCES
- Les Mouvements de terrain de la côte du Calvados. Recherches et prévention (ERT), for giving informations on shallow structures, lateral edges and water saturation. SP was conducted in the upstream-downstream profile, in order to confirm the hypothesis of functioning and define the boundary conditions of the middle zone thanks to both ERT/seismic surveys.

RESULT OF THE CROSS-INTERPRETATION

The different geophysical methods complement one another:

- SP & ERT are completing each other on the hydrogeological knowledge (water flows, internal saturation).
- Coupling seismic and ERT surveys allows refining the structural model for depth and lateral bounds.

Through that work, the knowledge was clearly improved in many ways:

- Robust assumptions have been issued from the SP mapping about the groundwater preferential circulation at the landslide scale;
- The limits and thicknesses of chalk panels, sands and marls are now better-constrained at the middle of the Cirque des Graves thanks to both ERT/seismic surveys.

From these cross-geophysical data, numerical models will soon be conducted thanks to the hydromecanical software FLAC3D, in order to confirm the hypothesis of functioning and define the boundary conditions of reactivation of this landslide.