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Delineation of internal landslide structures using complex conductivity imaging and geotechnical investigations – case study Hofermühle, Lower Austria

Christina Karl (1), Margherita J. Stumvoll (1), Jakob Gallistl (2), Adrian Flores-Orozco (2), and Thomas Glade (1)

(1) ENGAGE – Geomorphic Systems and Risk Research, University of Vienna, Department of Geography and Regional Research, Vienna, Austria (a01108911@unet.univie.ac.at), (2) Geophysics Research Group, TU-Wien, Department of Geodesy and Geoinformation, Vienna, Austria

Detailed knowledge about the internal structure of a landslide body is of major importance to understand landslide dynamics and potential triggering factors, as required for potential risk assessment. A variety of methods is available for subsurface investigations, which provide direct information (yet punctual) about the mechanical properties of the subsurface such as percussion drilling (PD) and dynamic probing heavy (DPH); whereas geophysical techniques, such as electrical imaging, have been investigated to gain quasi-continuous information about subsurface physical properties. In particular, the complex conductivity (CC) imaging method has emerged as a promising technique to improve the lithological interpretation, as it provides information about the electrical conductive and capacitive properties of the subsurface. Yet, it has been rarely applied for landslides investigation. Hence, in this study, we present the combined investigation using CC and direct methods (PD and DPH) for the characterization of the internal structure of the Hofermühle-landslide.

It is located in the region of Waidhofen/Ybbs in the alpine foothills in the Province of Lower Austria and is classified as a slow moving, shallow, complex rotational landslide with several different sliding planes, affecting an area of approx. 50.000 m^2. Due to the morphology of the slope, shallow and slow sliding processes have been coupled in the past with faster processes like earth flows. These dynamics can be expected to be re-activated in the future, which might even pose a risk to human settlements and infrastructure. The study area is situated in the transition zone of the (Rhenodanubian) Flysch Zone and the Klippen-Zone; thus, mainly related to fine grained materials, including layers of marls, clays, sandstones, and limestones. Due to their high weathering susceptibility, deeply weathered regolith with thick soil layers has developed.

PD was conducted at a single location, giving ground truth information on soil specific values for different horizons. The core was analyzed in terms of gravimetric water content, electrical resistivity as well as particle-size distribution. DPH yielded point information on the stratigraphy as well as the depth of the bedrock for three locations. To assess the spatial variations in the subsurface 7 parallel CC profiles were collected by means of time-domain IP measurements, including normal-reciprocal pairs for quantification of data error. CC imaging results reveal high electrical conductivity values as expected for fine-grained materials with high clay content, limiting the interpretation of the electrical conductivity images. Nevertheless, the images of the induced polarization effect reveal a clear layer at depths between $\sim$5 and 15 m, associated with an increase in the imaginary component of the CC, likely associated to changes in the compaction of the materials, and the contact to the bedrock. The CC imaging results are validated through DPH and PD. Lateral variations in the electrical properties reflect the alternating layers of clays and sandstone. Our results suggests that multiple sliding planes could exist within the slope; yet, further analyses are required to fully understand the potential landslide hazard and to link the subsurface conditions to dynamic changes of slope stability in the future.