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Characterization of a clayey landslide by integral application of multiple geophysical and geotechnical methods

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Landslides are natural hazards posing a threat to infrastructure and human life. Understanding the internal structure of landslides is critical for managing the associated risks. Geotechnical methods are a common way to characterize the subsurface properties of interest (e.g., lithology, water content, plasticity, etc.), yet they only provide information at discrete measurement points. Economic and logistic limitations constrain the applicability of geotechnical measurements to gain information with the required spatial resolution. Furthermore, a simple interpolation of geotechnical data might bias the result, since subsurface properties can change even at a small scale. Geophysical methods provide quasi-continuous information about subsurface properties, yet the quantitative interpretation of such results requires complementary data. Hence, we propose the joint application of geotechnical and geophysical methods in landslide investigations. The study site is located in the "Flysch-Zone" in Lower Austria and consists of interbedded strata of sandstone and claystone covered by a weathered clay layer. We conducted five refraction seismic tomography (RST) and six induced polarization (IP) profiles distributed over the affected area (ca. 60,000 m^2) to investigate the landslide architecture. At the crest of the landslide, we also applied transient electromagnetic (TEM) soundings and low-induction number electromagnetic methods (EMI) to identify possible drainage systems and estimate the volume of potential sliding materials. Laboratory analysis of materials recovered from one core drilling and three trial pits provided information on soil physical properties and cation exchange capacity. Additionally, four Dynamic Probing Heavy (DPH) soundings were done to detect the sliding plane. Changes in the seismic velocities resolved by RST and in the electrical properties resolved by IP imaging are in agreement with those revealed by heavy dynamic probing, permitting a gapless delineation of the sliding plane. Based on the laboratory analysis of soil samples heterogeneities within the sliding mass detected by IP and electromagnetic investigations can be related to varying water and clay content within different geological units. Our results permitted to delineate between four different landslides within the study area and quantify their geometry.