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Determination of the potential shear plane of a clay-rich, deep-seated landslide using spectral induced polarization and geotechnical approaches: case study Brandstatt, Lower Austria

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Increasing knowledge about the landslide geometries is key to understand the factors driving the slope instability. Direct investigations can provide information about the soil properties or locate features that help to recognize the mechanism of the landslide failure. However, this information is punctual and requires the interpolation of the data, which may lead to uncertainties due to the complexity of the geological context. Geophysical methods offer the capability to broaden spatial information, covering extended depths, and do not require interpolation. In particular, the induced polarization (IP) method has proven to be a powerful technique for investigating the hydrogeological properties of landslides. This method offers advantages in discriminating between interfacial and electrolytic (electrical) conduction mechanisms, which is crucial for the accurate interpretation of imaging results in clay-rich landslides. This is attributed to the IP method's capability of extracting not only electrical conductive properties but also capacitive (i.e., polarization effect) properties of the subsurface and its frequency dependence.
In this work, we present the results of an ongoing investigation in the Brandstatt landslide (Lower Austria). This is characterized by a complex, slow-moving earth slides system, located in a geological transition zone between the Flysch and the Klippen Units and the Molasse zone, which is known to be a landslide-prone area. We applied a combination of different geotechnical methods, e.g., inclinometric measurements and dynamic probing (DP) tests, which have been carried out on the slope. We have conducted four IP profiles across the active area, each consisting of 32 electrodes with a spacing of 10 m. IP measurements were collected within frequency ranges of 0.25 to 225 Hz to discern the frequency dependence of the electrical properties and facilitate the quantification of hydraulic properties. The results of the investigations indicate different displacement rates and the presence of slip surfaces varying within the shallower layers. Additionally, IP imaging reveals the presence of high conductivity (50 mS/m) and polarization anomalies (20 µS/m) located in the first 40 meters, which are associated with the clay-rich area susceptible to movement. Furthermore, the contact with low conductivity values at depth indicates the geometry of the potential sliding plane. To potentially strengthen the correlation between the shallow information obtained by the geotechnical data and deep IP images, we examine the possibility of incorporating the results from surveys using electromagnetic methods.

These results demonstrate that the combined application of direct and indirect methods allows us to gain better insight into large-scale subsurface variations that control small-scale changes in the surface and near-surface.