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Geophysical study of a slope instability in the Swiss Alps using resistivity and induced polarization methods

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The understanding of water circulation into the ground has always been a major endeavour for geologists and engineers in the context of slope instabilities. Cost effective resistivity surveys may provide the fundamental information required by engineers for hydrogeologic modelling and risk assessment. The study area (2 km^2) is located in the Swiss Alps, near the Dent de Nendaz, on the South part of the Rhône valley. In this large slope (altitude ranging from 1700 m to 2200 m a.s.l.) ground instabilities have been detected. Therefore, the aim of this geoelectrical survey was to delineate the water infiltration into the subsurface, to identify preferential paths for water migration and to model the complex bedrock topography. This study is of considerable interest because of the construction (chalets, ski resort buildings, cable cars poles) and other geotechnical and land-management activities in the lower part of the slope.

In the region, large Alpine tectonic units of the Penninic domain are found (Pontis and Siviez-Mischabel nappes). It can be noted that the tectonic contact between the two nappes is masked by Quaternary sediments. From a mineralogical point of view, these nappes can contain a significant amount of graphite and pyrite. The bedrock is overlaid by Quaternary sediments, which cover the whole area. The Quaternary lithostratigraphy is highly variable and rather unknown. Nevertheless, moraine or blocks (fallen from the neighbouring cliffs) can be identified. To provide basic information on both the lateral and vertical variations of the resistivity in the region, two resistivity mapping surveys using a Schlumberger configuration (array length 60 m and 100 m) were carried out. More than 400 apparent resistivitiy data points were collected with these two array lengths. Then, 19 vertical electrical soundings were carried out to collect information about the thickness and the electrical properties of the Quaternary sediments. Two-dimensional (2D) electrical imaging (Wenner-Schlumberger config-

uration), including resistivity and time-domain induced polarization measurements, were also used to get a better understanding of the relations between the Quaternary sediments and the complex bedrock topography. The lengths of the profiles ranged from 235 m to 470 m.

The resistivity mapping results have enabled us to image the tectonic contact between the two nappes. On the eastern part of the slope, a narrow area that could represent preferential pathways for groundwater circulation has also been identified on the resistivity maps. The VES survey provided valuable information on the stratigraphy and thickness of the Quaternary sediments. With these data, a map of the bedrock topography was outlined. The 2D electrical resistivity imaging method provided reliable and detailed information on more complex features in the bedrock as well as on the various Quaternary units. The induced polarization method was particularly useful to discriminate between water circulation and occurrence of graphite or pyrite in the bedrock. The various springs located in the built area are well correlated with the identified preferential pathway. Tracing experiments are currently being carried out to refine the hydrogeological modelling in the region.