Validation of the Permafrost and Ground Ice Map (PGIM) using Electrical Resistivity Tomography (ERT)

Maya Boschung

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Mountain permafrost is a sensitive climate indicator, significantly impacted by the continuing global warming trend. The degradation of permafrost increases the risk of natural hazards and can destabilize slopes and infrastructures in alpine regions. In order to assess and monitor such changes, accurate permafrost distribution maps are essential. The Permafrost and Ground Ice Map (PGIM) by Kenner *et al.* (2019) employs a dual mapping approach to differentiate between ice-poor permafrost zones (including possible-patchy permafrost) and ice-rich permafrost zones. Electrical Resistivity Tomography (ERT), a geophysical method based on the different electrical resistivities of substrate materials, is a standard method in mountain permafrost research and can accurately distinguish between frozen and unfrozen ground.

This study aims to validate the PGIM based on ERT measurements, thereby using a completely different and complementary dataset to those previously used for the validation of permafrost distribution maps. The BOGEO (Geophysikalische Untersuchungen zur Permafrostverbreitung im Berner Oberland) project offers a consistent and uniquely large ERT dataset, employed in this study to validate the PGIM within the open-source software QGIS. The main objective of the study is to assess the performance of ERT-based validation in different mapped PGIM zones. Additionally, the study aims to identify patterns regarding landforms, areas of potentially over- and underestimated permafrost, and the distribution of ERT validation points with elevations. The results show that 59 % of the entire PGIM is confirmed by ERT. Most of the contradictions in the PGIM arise from the overestimation of permafrost probability, predominantly occurring in the ice-rich permafrost zones. However, the ice-rich permafrost zones have a higher level of confirmation than the ice-poor zones. For the possible-patchy permafrost zones, the validation revealed that 62 % are permafrost-free. The highest level of confirmation is obtained for the permafrost-free areas, at 73 %. Regularities were also identified in the distribution of validation points over elevation. The confirmation of a permafrost gap between the ice-rich and ice-poor permafrost zones, as noted in Kenner *et al.* (2019), presents interesting prospects for future research. The implications of the validation results are illustrated with a field example at the Almagellerhütte, which highlights the importance of using diverse validation datasets.

Keywords: Permafrost distribution map – ERT – Swiss Alps

Prof. Christian Hauck (Unifr) and Christin Hilbich (Unifr)