Climate-change-induced changes in steep alpine permafrost bedrock. 13 years of 3D-ERT at the Steintälli ridge, Switzerland.

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Warming of mountain permafrost leads to growth of active layer thickness and reduction of rock wall stability. The subsequent increase of instable rock volumes can have disastrous or even fatal consequences, especially when cascading events are simultaneously triggered. This growth of climate-change-connected hazard, together with the recent increase of exposition of infrastructure and people, poses the alpine environments at a high risk, which needs to be monitored. Laboratory-calibrated Electrical Resistivity Tomography (ERT) has shown to provide a sensitive record for frozen vs. unfrozen conditions, presumably being the most accurate quantitative permafrost monitoring technique in permafrost areas where boreholes are not available.

The data presented here are obtained at the Steintälli ridge in Switzerland, which presents highly vulnerable permafrost conditions. A consistent 3D field set-up, the robust temperature calibration and the quantitative inversion scheme allow to compare measurements from the longest time series (2006-2019) of ERT in steep bedrock. A direct link to mechanical changes measured with tape extensometer is provided. Comparison of repeated hourly measurements as well as Wenner and Schlumberger arrays are also shown here, in order to increase the robustness of the delivered results.

Confirming the long-term observation from air temperatures, results from multiple parallel transects show an average resistivity reduction of 22%, concentrated at deeper layers of the permafrost lens. The permafrost area in the 3D cross sections also decreased from 30 to 10% (about 500 to 150m² in our transects), with losses mainly localized on the south-east part of the study site, but in some cases also extending to the north face.