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Geophysical Characterization of unstable Permafrost in the Turtmann Valley, Switzerland.

K.J. Merz (1), HR. Maurer (1), L. Rabenstein (1), T. Buchli (2), and S.M. Springman (2)

(1) Institute of Geophysics, ETH Zurich, Zurich, Switzerland (kaspar@aug.ig.erdw.ethz.ch), (2) Institute for Geotechnical Engineering, ETH Zurich, Zurich, Switzerland

Rising air temperatures in high mountain areas, caused by global warming, can lead to permafrost degradation, which may induce ground instabilities and landslides. To understand the associated thermo-hydro-mechanical (THM) processes associated fully, a detailed geotechnical, geophysical and hydrological characterization of a permafrost soil is needed. Based on this characterization, THM models can be developed to predict general permafrost behavior under changing environmental conditions.

A rock glacier in the Turtmann Valley, Switzerland has been selected for this study. It shows signs of degradation as well as displacements of up to several meters per year in some areas. The processes that cause these phenomena are still poorly understood.

Extensive geophysical and geotechnical measuring and monitoring campaigns have been carried out over the last two years to delineate (i) the volume of the rock glacier, (ii) the occurrence of ice and (iii) the distribution of internal shear horizons. Seven boreholes, each approximately 25m deep, were drilled to obtain geological information. The boreholes were equipped with thermistor chains and inclinometers to monitor temperature and displacements over time. First results indicate that the displacement is focused in a narrow zone at a depth of about 15 m. Geophysical measurements include so far four seismic lines, two geoelectrical profiles, one 3D geoelectric survey, several georadar profiles and cross-hole radar measurements. The seismic data were analyzed with refraction tomography, and the resulting tomograms allowed gross internal structures to be identified. They indicate that a bedrock barrier subdivides the rock glacier in two flow branches in its lower part. This agrees well with visual observations made at the surface. Tomographic inversion of the geoelectric data show that the central part of the rock glacier is ice-rich, whereas its front and sides are mostly ice-free. Furthermore there are indications of ice loss in the degradation zone. The georadar profiles, collected over the central part of the rock glacier, allowed the identification of several internal shear horizons. One of them lies at a depth of about 15 m, and is therefore interpreted as the currently active shear plane. By combining all the geotechnical, geophysical and surface measurements, we are currently establishing a comprehensive subsurface model, which will form the basis for subsequent numerical THM modeling.