# Novel subsurface measurement setup to investigate heat transfer processes within the debris mantle of rock glacier Murtèl (Engadine, eastern Swiss Alps)

Dominik Amschwand*, Martin Scherler*, Martin Hoelzle*, Anna Haberkorn**, Bernhard Krummenacher**, Hansueli Gubler***

*Alpine Cryosphere Research Group, Department of Geosciences, University of Fribourg, Chemin du Musée 4, CH-1700 Fribourg (dominik.amschwand@unifr.ch)
**GEOTEST AG, Bernstrasse 165, CH-3052 Zollikofen
***ALPUG GmbH, Richtstattweg 3, CH-7270 Davos-Platz

The summertime runoff from melting ground ice stored in debris-covered permafrost landforms is an increasingly important water resource in dry, deglaciating mountain regions. However, annual melt rates in these landforms are hardly known. Lacking quantitative process understanding on how energy flows across the surface debris mantle down to the permafrost table impedes the modelling and prediction of annual permafrost melt water availability.

Evidence from, e.g., warming-resilient rock glaciers and crushed rock railroad embankments indicates that air convection within the permeable debris mantle has a cooling effect, thus creating overcooled ground thermal conditions. We investigate heat exchange processes including air circulation and longwave radiation across the openwork debris mantle down to the permafrost table on rock glacier Murtèl. At this Swiss Permafrost Monitoring Network (PERMOS) key site, borehole temperatures down to a depth of 58 m and meteorological conditions have been measured since 1987 and 1997, respectively.

In August 2020, we instrumented natural cavities between the coarse blocks with a variety of sensors such as thermistors, hygrometers, pyrgeometers, sonic anemometers, hot-wire anemometers, and heat flux plates. This unique ‘subsurface weather station’ measures heat exchange processes within the debris mantle. We complemented the ongoing PERMOS atmospheric measurements by eddy flux, precipitation, and snow temperature measurements. In addition, a visible light and thermal infrared dual camera provides hourly images of snow cover and surface temperatures. To verify the energy balance calculations, we track the water provenance of the outflow in the rock-glacier forefield with electrical conductivity measurements and estimate the discharge from permafrost melt.

The huge amount of collected data will allow to explicitly model the energy balance within the debris mantle. While our project will provide more reliable ice-rich permafrost runoff forecasts at a yearly resolution, the gained process understanding will also contribute to improved predictions on downwasting rates of debris-covered glaciers and on the delayed response of cold rocky landforms to climate change.