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Chemical and physical characterisation of water in an alpine permafrost area (Col d'Olen LTER site, Italian NW-Alps)

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High altitude areas in the Alps are characterised by the permafrost environment, which reacts sensitively to climate change. During the last decades several studies on alpine permafrost-related hazards have been performed, but few studies have focused on the geochemical content of the water that drains permafrost areas or outflow from rock glaciers (Williams et al., 2006; Thies et al., 2007; Krainer et al., 2011). Rock glaciers have physical and chemical influences on interflowing waters and their discharge can be highly enriched in solutes. For example, unexpected high nickel and manganese concentrations exceeding the EU limits for drinking water have been recently reported in some studies investigating rock glacier discharges (Ilyashuk et al., 2014).
The present study aims to evaluate rock glacier solute fluxes into a high altitude lake in the Italian NW-Alps (Col d'Olen LTER site, Aosta Valley) in order to understand the impact of climate parameters on alpine permafrost, in particular the effects of permafrost ice melt on the water quality of mountain headwaters. This objective has been achieved through an integrated-multidisciplinary research programme involving climate analysis, rock glacier ground surface temperature investigation, water physiochemical and microbiological analyses.
Nine automatic and three manned weather stations located in the surrounding areas of the rock glacier (radius: 12 km) have been used to study the relationships between climatic parameters and permafrost dynamics. Moreover, meteorological data have been collected by installing portable instruments in situ, integrated in a Mini Automatic Weather Station.
To investigate the correlations between physiochemical features of water and the thermal state of the rock glacier surface, the ground temperature monitoring has been conducted. Temperature dataloggers have been buried 5/10 cm into the ground, regularly distributed on the rockglacier surface and in few surrounding sites. Total Station was used to achieve position for each datalogger and differential GNSS was used to acquire global geographic coordinates with centimetric precision in order to accurately interpolate ground temperature data grid.
Water quality monitoring was conducted using a multiparameter spectrometer probe. In particular, NO_3-Neq, DOCeq, TOCeq and turbidity were analysed, and UV-visible absorbance spectra (220-720 nm) were recorded every three hours during summer and early autumn seasons. Water sampling in the rock glacier lake (and related inflows) was conducted on weekly basis starting with the initiation of snow melt runoff until freeze-up in the early autumn. Moreover, the ablation water of the Indren Glacier (located in the study area) has been analysed in order to use it as reference data. Water samples have been analysed for anions, cations, trace elements, nutrient content (TOC, DOC, TDP, DOP, TDN, DON), EC (Electrical Conductivity), Eh (redox potential) and pH. Finally, in order to assess microbial diversity and abundance of communities, functionally related to ecosystem nutrient dynamics, diversity and abundance of microbial communities were analysed. The fine material in the permafrost feature has been characterised through the determination of Ntot, Corg, N forms and heavy metals.