Almost 25 years of permafrost research

In the western part of the Swiss Alps near the Gemmipass, a long-term permafrost monitoring site (fig. 1) has been further developed by the University of Berne in 1987 to observe the further development of three rock glaciers and different periglacial processes and landforms. [5,6]

Situated in a relatively warm and wet climate at elevation levels between 2450 and 2850 m asl., this test area became one of the longest permafrost-related temperature and kinematics time series in the Swiss Alps and owns the "reference site" status within the national permafrost monitoring network PERMOS.

The main objective of the current research in this area is to improve the understanding of the rock glacier dynamics regarding the evolution of ground surface temperatures and terrain movements observed during the past two decades. Over the monitoring period several climatic events occurred and the air and ground temperatures and the kinematics as well show considerable changes in long-term and a high seasonal and inter-annual variability (fig. 3-6).

The observation period was rich of climatic events with high variations from year to year. The GST seems to react very sensitive to both, cooling and warming events and is highly influenced by the snow cover. Remarkable are the strong increase in MAGST during the hydrological year 2002/03 due to a superposition of a reduced cooling in the precedent winter and the heat wave in summer 2003 (fig. 3). This caused also a strong positive anomaly in the bi-annual mean GST until 2004 (fig. 4). Equally to this positive anomaly, the period from 2004 to 2006 was characterized by a very effective cooling of the ground with a negative sum of the freezing & thawing degree days by the end of the hydrological year (fig. 5).

The activity pattern and the morphology of rock glacier A were changing during the last decade: Besides of an overall increase in velocity (fig. 6), some parts at the rock glacier sides seem to become inactive while creep velocities in the center were increasing up to 400% compared to the average velocity before 1990 and thus forming distinctive shear zones (fig. 7). This behaviour was first detected by photogrammetric analysis [5] and can now also visually be observed from the images of a newly installed webcam.

Conclusions and Perspectives

The spatial pattern of rock glacier creep and the changes in morphology should be observed more in detail. A combined qualitative (using webcam images and terrestrial photographs) and quantitative (using digital photogrammetry) research approach could be suitable for this task. To have a closer look on the influence of melt water infiltration on rock glacier dynamics, terrestrial surveys will be done in future also in spring and autumn and extended to the other rock glaciers in the valley.

In addition to the GST measurements, complementary geophysical investigations will be done in summer 2013 to determine the internal structure of the rock glaciers.

For rock glacier A a comparison with electrical resistivity measurements (ERT) and refection seismics from 2007 and 2008 [3,7] will probably lead to further findings about the distribution and evolution of the subsurface ice content.

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