Geophysical Research Abstracts, Vol. 9, 10671, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-10671

Inventory of ventilated cold scree slopes and rock glaciers in the Swiss Alps and Prealps

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Investigations about the internal circulation of air and the concomitant occurrence of ground negative thermal anomaly and sometimes permafrost within scree slopes and inactive and relict rock glaciers were initiated were initiated since 1997 in several sites between 650 and 2'800 m a.s.l in the Swiss Alps, Prealps and Jura mountains. The results from more than 50 sites show that the circulation of air is a mechanism common to almost all prospected sites. An annual negative anomaly of the ground temperature (0.5 to 7°C) occurs at the base of the debris accumulation independently of the slope orientation. Moreover, permafrost is likely to occur in most cases (according to electrical resistivity measurements), even in the sites with a mean annual air temperature (MAAT) between +1 to +5°C depending on elevation.

Air circulation throughout an accumulation of loose sediments is primarily controlled by the thermal gradient between the surrounding air and the ground. The flow direction seasonally reverses: to an ascent of relatively warm light air in winter, which favours consequently the penetration of cold air at the base, succeeds a gravity discharge of relatively cold dense air during summer.

Several evidences at the ground surface allow detecting the presence of a ventilated debris accumulation: snowmelt window, hoarfrost, basal icing of the snow cover, funneling, condensation fog, ground icing, aspiration holes, dwarf treesĚ Evidences of winter ascending air circulation were detected everywhere, while evidences of summer gravity discharge of cold air were only clearly identified in the sites located below ˜2'000 m a.s.l. Performing a BTS (bottom temperature of the snow cover) mapping after a long period of cold weather has revealed to be a valuable method for determining both the efficiency and the spatial extent of a ventilation system acting throughout

a debris accumulation even in the presence of a thick snow cover. A characteristic ground winter temperature pattern was encountered with an overcooled zone in the lower part of the scree slope and in the rock glacier, and positive ground temperatures (+1 to +5°C) in the upper part of the slope. The lowest ground temperature area (-8 to -10°C) is located just above the foot of the scree slope, where the aspiration of winter cold air is the strongest. In the middle part of the scree slopes, a rapid transition in the temperature pattern can be observed in all investigated sites.

The granulometry seems to play a major role in the efficiency of the air circulation. It could explain the diversity encountered between the investigated sites and between different parts of a same site, in particular concerning the spatial extent and the magnitude of the ground thermal anomaly. Measurements performed in gravel pits show that air circulation seems to be possible (but with low efficiency) even with a grain size of 3-4 mm.