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Drilling in a low elevation cold talus slope (Dreveneuse, Swiss Prealps)

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A cold talus slope at Dreveneuse (1550-1610 m a.s.l., Swiss Prealps, MAAT about +4°C) was drilled and instrumented in November 2004 in order to document and better understand the ventilation process causing the strong overcooling of the lower part of the debris accumulation. The acquired dataset has permitted to observe both the particular geometry of the permafrost in the talus slope and its aggradation between 2004 and 2006.

The talus slope, consisting of limestone blocky and pebbly clasts, is about 100 m long, inclined between 25 and 35° and covered in its lowermost third by a singular forest of dwarf spruces, a typical indice for cold ground temperature in summertime. The lower part of the talus slope lies on a late-glacial lateral moraine of a local glacier. Two boreholes were drilled in the talus slope for temperature logging. They have been complemented by further measurements especially in the lower part of the slope (ground surface temperature, speed and direction of the “talus wind”, air humidity in the blocky subsurface, snow thickness and temperature, air differential pressure between the subsurface of the talus and the outside, etc.). The main borehole BH1, 15 m deep, is located in the middle part of the slope, a few meter above the dwarf spruces area. The porous blocky layer is 10 m thick at that place, covering at least 5 m of much finer loose sediments. By the end of November 2004, the temperature at 10 m depth was about +2.5°C. The second borehole BH2, 5 m deep, was drilled in the lower part of the slope. The porous blocky superficial material was here only about 4 m thick. During the two cold winter 2004/05 and 2005/06, the blocky talus slope cooled strongly, especially at BH1. A minimal temperature of -8 to -9°C was registered at a depth of 8.5 m. As a consequence, the ground began to freeze in winter 2004/05 beneath the blocky talus down to more than 13 m depth. In BH1, the minimal

MAGT (mean annual ground temperature) value has been recorded at 8.5 m depth in BH1 (about -1°C), but the temperature becomes slightly positive in autumn. Despite slightly warmer MAGT, the ground is remained frozen between about 10 and 13 m depth since winter 2004/05 (it was still in December 2006). In BH2, a thin permafrost is also occurring but much closer to the surface (between about 2 and 4.5 m).

The wind sensor in the lower part of the slope recorded a velocity of the air discharge in summer by 0.3 to 0.4 m/s, but a stronger aspiration (up to 0.8 m/s) by very cold temperature during a snow free period in late fall. The wind sensor did not work during winter time, but the differential pressure sensor revealed for all the winter season that the contrast between the ground subsurface and the outside was dependent on the outside temperature, with an increasing contrast by cooling temperature. The lower pressure at the base of the snow cover is assumed to be caused dynamically by the ascending air movement throughout the talus slope. The mecanism forces the air the penetrate in the ground through the snow cover.

All these data have demonstrated the efficiency of the ventilation system (whose driving factor is the temperature gradient between the inside of the talus slope and the outside air) for cooling deeply and stongly the ground interior, the continuity of the ventilation process even after the development of a thick snowcover (more than 2 m deep in winter 2005/06), the peculiar geometry of such an advective-induced permafrost and the potentially rapid changes that can affect its geometry.