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Thermal regimes in bedrock and open fractures in the Nordnes rockslide, Norway

Hanne Hvidtfeldt Christiansen (1,2) and Lars Harald Blikra (3)

(1) Geology Department, The University Centre in Svalbard, UNIS, Longyearbyen, Norway (hanne.christiansen@unis.no), (2) Department of Geoscience, University of Oslo, Oslo, Norway, (3) Åknes/Tafjord Early Warning Centre, Stranda, Norway (lhb@aknes.no)

The Nordnes rockslide site is located in the arctic part of the periglacial mountain landscape of Northern Norway at 69°30'N. It consists in the upper part of 1-10 m wide and 1-10 m deep open fractures. Extensive displacements measurements using GPS surveys, crackmeters, tiltmeter and lasers establish the intermunicipality monitoring programme, which shows ongoing deformation of the rockslide. In the rather special topographical setting of the open fractures we have during the International Polar Year 2007 to 2009 recorded the thermal regime of the upper part of the bedrock and of the air in the cracks for attempting to determine whether the recorded deformation can be geomorphologically controlled by bedrock surface expansion and contraction and/or by seasonal freezing or even by permafrost, or if only normal gravitational processes control the observed displacements.

The upper 40 cm bedrock thermal conditions have been investigated in different exposures to identify the seasonal freezing depth and length, for determination of the influence of potential ice segregation processes causing weathering of the bedrock surfaces. The data show generally that that the bedrock surface is in the -3 to -8C freezing window for 3 to 6 months. Likewise 250 cm deep bedrock thermal monitoring have been carried out in three boreholes during one year at 900 m, 800 m and 625 m asl. extending over the area from the upper part of the unstable area and into the stable area above, for determination of the regional permafrost zone. These results in combination with thermal evidence from other deeper boreholes from the same setting in the same region show that seasonal freezing extends 5-10 m down, and that a potential active layer also is in the order of 5-10 m deep. The air temperatures in the cracks show significant cooling during winter, when the cracks have a thick snow cover, thus demonstrating the potential existence of permafrost in deeper part of the cracks and in the ground just around these.

Automatic photography has been used for the last 4 years to study the seasonal snow cover duration and thickness in the open cracks. This shows that a thicker snow cover only develops in mid winter, with maximum amounts of snow in March and April, but also that not all snow melts during summer in the deeper parts of the open cracks. In addition we have found small pockets of ice in closed spaces of the bottom parts of the open crack, indicating the presence of permafrost. The combination of thermal data and the special seasonal variation in the rockslide deformations indicate that most likely refreezing of snow meltwater goes on in the open cracks for a considerable period from late summer, autumn and into the early winter, when the recorded rockslide deformation is largest. In late winter no significant deformation is recorded when the ground is constantly frozen, but there is a significant potential for ice segregation to occur where moisture is present in the rock.