Permafrost distribution in talus slopes

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In the context of a warmer climate, the localization of permafrost in steep sedimentary terrain is of great importance. In order to identify the permafrost distribution and characteristics in the talus slopes of the alpine periglacial belt, about 15 talus slopes located mainly in the Mont Gelé (Verbier-Nendaz) and Arolla areas (Swiss Alps) were studied. The traditional methods of permafrost prospecting were used, i.e. ground surface temperature measurements at the base of the snow cover (BTS), year-round ground temperature measurements and DC-resistivity prospecting.

In most cases, permafrost was found in the lower part of the slopes. At this place, electrical resistivities are the highest (Figure 1). The typical DC resistivity curves display a resistive layer near the surface. Then, the resistivities decrease. A third thicker layer with higher resistivities can then be identified, before the values decrease again (Figure 2). The presence of a conductive layer (blocks supported by a fine-grained matrix) above the third layer is an argument to interpret this one as frozen sediments. Another argument is the shape of the curves, which is typical for permafrost in coarsy sediment terrain. It corresponds to what is generally measured on rock glaciers. The difference is the resistivity value of the third layer, which is generally higher in rock glaciers than in talus slopes. Finally, BTS values are the coldest in the lower part of the slopes.

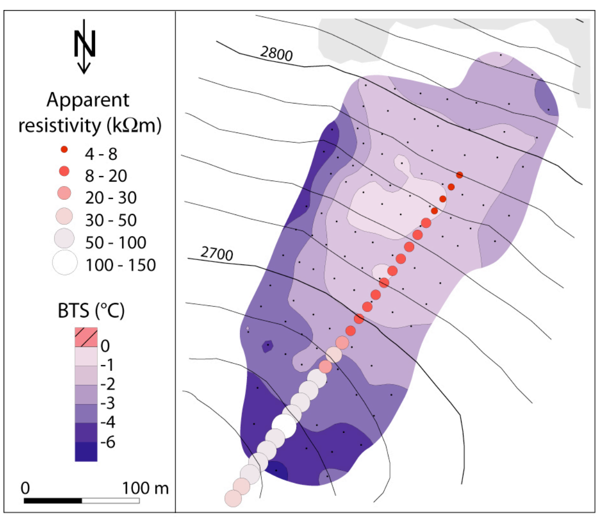

Figure 1. Example of results obtained on a talus slope (Tsena Refien, Arolla). The highest apparent resistivities (inter electrodes interval: 12.5 m) and the coldest BTS are located in the lower part of the talus.

Higher in the slope, permafrost is generally absent. DC resistivities gradually decrease, up to the disappearance of the third resistive layer. BTS values warm up and get closer to 0°C. In some cases, they even get positive.

Due to security reasons (blocks falls, avalanches), data is rarer in the uppermost part of the slopes. However, we can observe that, in some cases, DC resistivities are a bit higher than in the middle part of the slopes. In parallel, BTS values are a bit colder. This shows that permafrost may be present in the uppermost part of some talus slopes, directly at the base of the head wall.

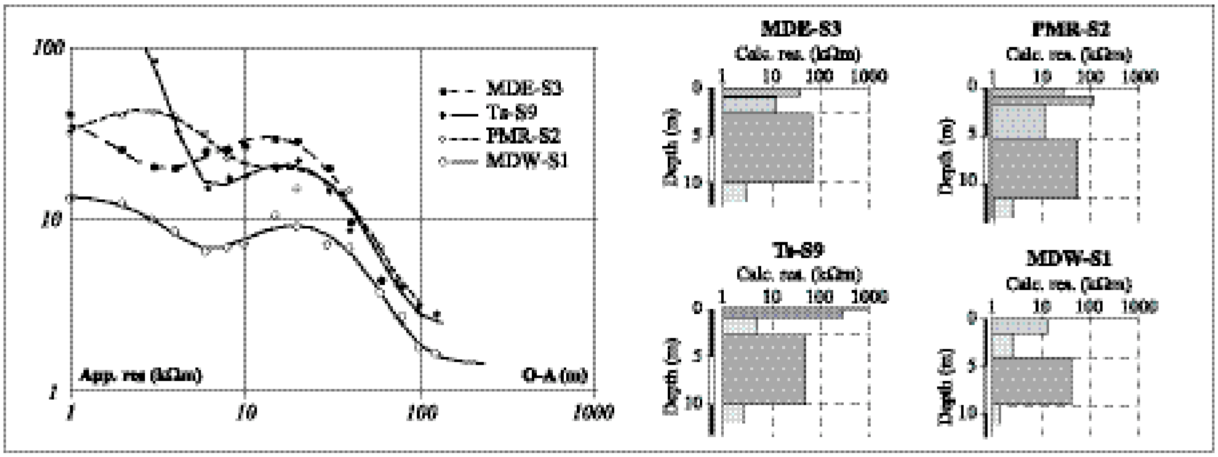

Figure 2. Typical curves of DC-resistivity soundings measured on the lower part of talus slopes located within the discontinuous permafrost belt.

Different factors can explain this particular permafrost distribution. In addition to the redistribution of snow by avalanches, that protects the ground against summer warming (e.g. Lerjen et al. 2003) and the presence of coarse blocks at the foot of the talus that favour the ground cooling (Harris & Pedersen 1998), a third factor was evidenced. Some studies have shown that internal air circulations are responsible for the presence of permafrost in the lower part of talus slopes located more than 1000 m below the regional lower limit of discontinuous permafrost (e.g. Delaloye et al. 2003). Numerous data of this study show that this mechanism is also active in the discontinuous permafrost belt.

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