Permafrost distribution and characteristics in limestone talus slopes located near the lower limit of alpine discontinuous permafrost (Swiss Alps).

Pieracci Kim & Lambiel Christophe

Institute of Geography, University of Lausanne, Switzerland

The permafrost distribution and characteristics were studied in ten limestone talus slopes in the Grand Chavalard area (Western Swiss Alps, 46°11'N/7°07'E). The prospected landforms are located between 2300 and 2600 m a.s.l., that is at the lower limit of alpine discontinuous permafrost. The grain size is in most cases lower than 20 cm. DC resistivity prospecting and BTS and/or year-round ground temperature measurements were carried out on the different slopes.

Whereas bedrock displays resistivity values between 0.5 and 1 kΩm, values ranging from 10 to 15 kΩm were measured on unfrozen loose sediments. These relatively high resistivities may be explained by the obviously high porosity of a limestone talus slope, in which the matrix would be reduced because of the karstic dissolution. This makes the interpretation of resistive layers sometimes difficult.

A strong contrast in electrical resistivities between the upper and lower part of the talus was evidenced on most of the prospected landforms. The low values measured in the upper parts (15 to 20 kΩm) probably point to the presence of unfrozen sediments, while resistivities ranging from 50 to 150 kΩm indicate that permafrost is certainly present in the lower part of the slopes (Figure 1).

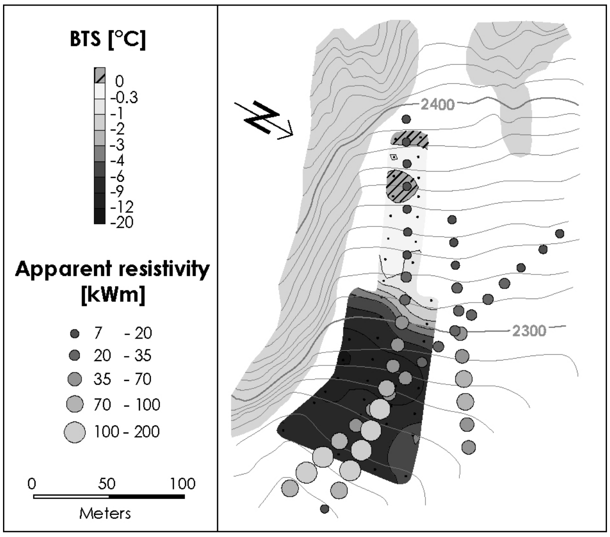

Figure 1. Apparent resistivity (Wenner configuration, inter-electrodes interval: 15 m) and BTS measurements on the Creux du Bouis talus slope.

BTS and year-round ground temperature measurements also display a strong contrast between the upper and lower parts of the slope in the porous prospected talus (Figure 1). The winter temperatures are the coldest in the lower part (up to -15°C), whereas positive values were sometimes measured in the upper part of the slopes. This can be explained by a chimney effect (air advection), which can have a strong impact on the thermal regime of this kind of sediment deposit. This contrast is much less marked in sediments with reduced porosity (presence of fine-grained matrix, permafrost saturated with ice). In this case, thermal exchanges are mainly controlled by conduction and/or convection.

Other studies have already demonstrated that permafrost seems to be confined to the lower part of some talus slopes. It has been demonstrated that the ventilation system evidenced in many scree slopes located far under and around the lower limit of discontinuous permafrost plays an important role in the distribution of permafrost (e.g. Delaloye 2004; Lambiel 2006). This process is active in some of the landforms prospected in this study and should even be very efficient according to the high porosity related to limestone sediments.

REFERENCES

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