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Permafrost detection in the headwalls of receding glaciers at the Dachstein Massif, Northern Calcareous Alps, Austria

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The Northern Calcareous Alps cover a large area of the Austrian Alps forming a boundary zone between the Alpine Foreland to the north and the crystalline Central Alps to the south. Generally, climate in this area is more maritime compared to the mountain ranges further south. Few small glaciers are to be found mostly on north-facing slopes. The Northern Calcareous Alps reach maximum elevations of about 3000 m asl. Some of highest summits are to be found are located in the Dachstein Massif reaching 2995 m asl (47° 28′ 32″ N, 13° 36′ 23″ E). Occurrence, thickness and thermal regime of permafrost at this mountain massif are widely unknown and knowledge is based on simulations only. In contrast, the glaciation changes at this mountain massif (e.g. Schladminger and Hallstätter glaciers) have been well documented for decades. Within the framework of the research project ROCKING ALPS – dealing with frost weathering and rockfall in alpine regions – knowledge of permafrost distribution in the headwalls surrounding the receding glaciers is substantial to understand rock decay. For this reason, several techniques have been applied in order to detect bedrock permafrost. During the winter of 2012 22 i-buttons (temperature sensors) were attached to rock walls with different orientations but at similar elevations (2600-2700 m asl). Most of these sites were later covered by an insulating winter snow cover therefore allowing the calculation of the base temperature of the winter snow cover (BTS). These BTS data have been used as a first indicator of permafrost presence. In selected rock walls of several mountains in the massif – Koppenkarstein (2863 m asl), Dirndln (2829 m asl) and Gjaidstein (2794 m asl) – additional 2D-geoelectric surveys (five ERT profiles with a length of 100 m and 2 m electrode spacing) were measured in summer 2013. The high resistivities (> 50.000 ohm.m) at about 1.5 m depth and deeper strongly suggest permafrost existence inside the bedrock at all sites. Interestingly, bedrock permafrost was also detected at an immediate glacier margin which has been ice-free for 2-3 decades at maximum. Possibly the glacier at this site was too thin to have a sufficient insulating effect on the rock and hence was cold-based in this position. Alternatively permafrost aggradation occurred rapidly in the few last decades at this site. A new and innovative method in geomorphology and permafrost research is the use of infrared photography. By using this method the gaps between the punctual temperature sensors and the profile lines of the geoelectric measurements can get closed. By using infrared photography it was possible to visualize patterns and amplitudes of the diurnal variations of the surface temperature. First results showed a faster and deeper cooling of the permafrost areas compared to non-permafrost rocks, which is in accordance with the BTS and ERT data.