Submitted Abstract

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Abstract

Infrastructures at high altitudes are predominantly founded or anchored in low porosity permafrost bedrock. The ongoing permafrost degradation poses an increasing risk of destabilization and damages to these infrastructures with potentially severe social and economic consequences. To cope with this situation, a complete process understanding of these low porosity permafrost systems is required. Multimethod approaches were already successfully applied in ice-rich conditions. However, quantitative studies in ice-poor bedrock characterized by confined pore space, where petrophysical relations are known to be even more clearly defined, have rarely been investigated.

In this study, we present a quantitative approach to long-term monitor the frozen area of low porosity permafrost bedrocks by combining data sets from electrical resistivity and seismic refraction measurements. The data sets shown here were recorded between 2010 and 2021 at two touristic-relevant sites with foundations in low porosity bedrocks affected by permafrost degradation: the Zugspitze crest (Germany, 2.855 m asl) and in the Hanna-Stollen at the Kitzsteinhorn (Austria, 3.029 m asl). Transferring the gained relations from laboratory calibrations between temperature, resistivities, and p-wave velocities to field measurements, site-specific temperature changes can be quantitatively estimated.

Our applied techniques enable an accurate quantification of permafrost degradation dynamics and can therefore highlight areas where mechanical changes caused by increasing temperature lead to significant stability reduction. In the context of climate-change, this non-invasive method is a fundamental tool for improving the hazard potential assessment of high-alpine infrastructures with foundations and anchoring in thawing permafrost.