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Rock permafrost at the Piz Corvatsch – A multi-method instability analysis

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The process-related and systemic changes in mountain permafrost environments in relation with local and regional climate changes call for a detailed monitoring and analysis in order to enhance the systemic understanding and to allow for future potential hazard mitigation.
When addressing the interaction of different processes affecting the rock permafrost system on various scales, including both space and time, a combination of multiple methods should be chosen to allow for a comprehensive data set as the basis for a systemic assessment.
A multi-method instability analysis for rock permafrost systems was implemented at the 'Piz Corvatsch' (3303 m a.s.l.) in the Upper Engadin in Switzerland. In August 2009 and 2010, a combination of several methods – electrical resistivity tomography (ERT), refraction seismics, extensometer measurements, laser scanning and GPR – has been applied at our study site, the 'Kleen Chasselett', a beak of rock consisting of different types of schists, at 2700 m a.s.l.. Additional information was gained from geological analysis, geomorphological mapping and meteorological data.
GPR data and a 2 year laser scanning record were used to estimate a rock wall retreat rate since deglaciation. Short-term opening of deep-reaching fractures was monitored by extensometer measurements in order to indicate speed and possible directions of movement. Laboratory tests of rock samples taken from the study site reveal site-specific values for the transition from wet to frozen rock for both ERT and refraction seismics. The interpretation of ERT and refraction seismics demonstrates the relevance of the existing joints and fault systems for the hydrologic conditions in the rock as well as the constraints set by the geologic conditions for the spatial extent of permafrost.
Overall, the study site provides insight into a lateral rock spreading and toppling system developed at the fringe of (rock) permafrost and therefore representing sensitive - and at least locally - transient system characteristics. The multi-method approach is useful to address the present system state and help to decipher possible internal and/or external impulses causing reactions made visible through changes in the rock permafrost distribution or rock instabilities. Additionally, the applied methods consider a range of different time scales and aim to bridge the gap to past events and impulses. This is an important aspect of permafrost related stability analysis as the current system state and its development over time both affect the system's sensitivity towards future impulses.