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Short- and Long-term Thermal and Mechanical Transition in Norwegian Permafrost Rock Walls.

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The frequency of landslides in permafrost rock walls has significantly increased in the last decades. Since permafrost degradation is strongly linked to a decrease in rock strength and overall rock mass stability, high-altitude rock walls are prone to permafrost related instabilities in the context of global climate warming. In Norway, seven out of 300 mapped instable rock walls are classified as high-risk sites of which at least two (Gamanjunni and Mannen) are believed to be situated in permafrost conditions. Here we use laboratory-calibrated 2D and 2.5D electrical resistivity tomography, rock mechanical testing as well as thermal and mechanical modelling to (i) gain insights into the current thermal and mechanical dynamics of these two high-risk sites and (ii) to show how long-term thermal changes over the Lateglacial / Holocene affect the evolution of rock wall instabilities.

In this study, we investigate two of Norway's top risk rock wall instabilities to evaluate how short-term (10 to 100 a) thermal variations can influence the local mechanical regime and, interestingly, vice versa. 2D and 2.5D electrical resistivity tomographies, which we calibrated for temperature using samples from site, reveal the existence of permafrost with a strong influence of slowly changing topographic features such as active landslide scarps and fissures. The results of over 100 rock mechanical tests of samples from both test sites show a 15 to 20 % strength reduction upon thaw. This data can be used to set up mechanical models in order to analyze the current local mechanical regime. Both test sites, however, show a long-term (0.1 to 10 ka) history of rock wall instability, hence the long-term trajectory of the thermal and mechanical transition should not be neglected. We use the output of a long-term transient heat flow model (CryoGrid2D) in combination with a multi-stage continuum mechanical model on a fjord scale level to show how the evolution of rock wall temperatures since deglaciation affects the long-term stability of steep fjord flanks.

Here we show the short-term thermal impact on local rock wall stability and vice versa in the context of long-term thermal and mechanical evolution of extreme fjord topographies.