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Molards as proxies of permafrost degradation: investigating physical downscaled models

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Current climate change causes an increasing retreat of mountain permafrost. This retreat presents safety hazards due to more frequent slope instabilities. Thus assessing the state and evolution of permafrost is crucial. Unfortunately, mapping permafrost extent and retreat is not as simple as for other cryospheric landforms because permafrost is not directly detectable by remote sensing. However, in some mountain landslides, one can observe remnants of formerly ice-cemented blocks that degrade into cones of loose debris. These so-called molards imply the presence of an area of discontinuous permafrost at the level of the detachment zone.

To understand the processes that form molards we studied the degradation of the initial ice-cemented blocks by physical modeling. In nature, the height of these initial blocks ranges from 50 cm to up to 15 meters. For our experiments, it was, therefore, necessary to downscale the initial block to a more manageable cube size of 30 cm. These blocks are left to degrade under a controlled lab environment while being observed by a timelapse photogrammetric system as well as temperature and humidity sensors. The current experiments are investigating the effect of different sediment compositions, shape- and slope parameters on the decay and shape of the resulting molards. We find that especially the content of very fine sediment has a strong impact on the decay of the initial block due to its strong cohesion.

These initial results will be used to scale the experiment to the maximum size feasible in the lab: a 70 cm cube with a weight of up to 700 kg. The final goal is to create a numerical model based on the experimental findings, making it possible to distinguish molards from other similar landforms, such as hummocks or hummocky moraines. This knowledge can be used in the long term to identify and study these molards via remote sensing over a much larger area.