Friction behaviour of giant rockslides considering temperature effects and impact loading effects

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Abstract: Giant rockslides occurring in high-elevation mountainous regions can evolve into highly mobile and channelised rock avalanches, posing severe risk to local communities. The basal friction behaviour plays a critical role in governing their mobility throughout the runout process. In this study, we conducted two types of laboratory mechanical tests, the high-speed rock friction test and the undrained ring-shear test, to investigate the possible frictional mechanisms that exist from the rockslide initiation to the runout of the resulting avalanche. Results from the high-speed rock friction tests show that the generation of rock powder is a key factor responsible for frictional weakening, while its subsequent expulsion and recrystallisation can lock the rock interface again. These findings explain the frictional processes occurring at rock interfaces during the early stage of failure. For the shearing behaviour of granular materials during avalanche runout, ring-shear tests under different drainage conditions demonstrate that both normal stress and shear displacement are positively correlated with the generated temperature, whereas shear rate shows little effect. Under undrained condition, the temperature increase is approximately 35% of that observed in the drained case, accompanied by a complete loss of strength. Moreover, friction weakening effect was further studied in ring-shear tests with impact loading, which show that a liquefied basal layer can form near instantaneously when the substrate is loose and weakly consolidated. To sum up, these results highlight the complicated effects of thermal, mechanical, and hydraulic processes, which jointly contribute to the evolution and mobility of catastrophic landslide hazards, underscoring the need for further investigation.