Characteristics of acoustic and micro-seismic signals in steep bedrock permafrost on Matterhorn, Switzerland

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Problem statement
Change in permafrost conditions can lead to rock slope destabilization
⇒ Rising risk due to coexistent growth of vulnerable socioeconomic activities

The ability to detect precursor events of a rock slope failure remains limited
⇒ Integrated signal of a rock mass to complement surface displacement

Main findings
A Strong change in waveform characteristics with different propagation paths disables feature detection by cross-correlation
B Significant signal amplification in frequency band 33-67 Hz
C The event energy rate in this amplifying 33-67 Hz band is not sensitive to temperature, a prerequisite for successful slope stability assessment

Research design and experimental setup
1 We measured acoustic emission (AE) and micro-seismic (MS) activity generated in steep bedrock permafrost at Hörnligrat field site

2 We explored the AE/MS characteristics through artificial point sources at location 1-4 (indicated with 6) using a rebound hammer to simulated surface detachment events

3 We investigated the sensitivity of triggered events to temperature

![Image of Matterhorn and experimental setup]

CR = crackmeter
AE = acoustic sensor
AM = accelerometer
SM = seismometer

Estimation of signal amplification

Principle of seismic reciprocity:
⇒ 2 stations with 1 source = 1 station with 2 sources

Ratio between location 3 and location 4 in signal frequency domain. Nine artificial point sources at each location results in 81 combinations:

![Graphs showing signal amplification]

⇒ Amplification in frequency band 33-67 Hz, origins remains unclear

Results of artificial point sources at 4 locations

Seismograms and powerspectrums (dB) of 2 events for each source location

![Graphs showing seismograms and powerspectrums]

indicates triggered events with STA/LET without filter
++ indicates triggered events with STA/LET in frequency band 33-67 Hz
⇒ Inexisting cross-correlation between signals with different propagation path

Temperature sensitivity of triggered events

![Graphs showing temperature sensitivity]

⇒ Parameters of the events in the band 33-67 Hz are not temperature sensitive

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