Geophysical Research Abstracts
Vol. 15, EGU2013-616, 2013
EGU General Assembly 2013

Refraction Seismics in unstable Permafrost Rocks

Daniel Draebing (1) and Michael Krautblatter (2)

(1) Department of Geography, University of Bonn, Bonn, Germany (daniel.draebing@giub.uni-bonn.de), (2) Monitoring, analysis and early warning of landslides, Technische Universität München, Munich, Germany (m.krautblatter@tum.de)

Degrading permafrost in rock walls can cause instabilities due to changes in rock- and ice-mechanical as well as hydraulic properties. We used seismic refraction tomography (SRT) to evaluate the degradation of permafrost in steep rock walls. In the laboratory, p-wave velocities were measured on 22 low-porosity rock samples from arctic and alpine regions. In the field, five parallel NE-SW transects were installed across a crestline in the Steintaelli, Matter Valley, Switzerland, at 3070-3150 m a.s.l.. Time-lapse p-wave velocity measurements were performed in the summers 2006, 2007 and 2012. August 2012 was the second warmest month ever measured after the heat summer of 2003.

(i) Laboratory p-wave velocities show a velocity increase due to freezing that depends on lithology and the increase is dominated by a matrix velocity increase due to the developing ice pressure. As a result of ice pressure, anisotropy decreases up to 45 % in 15 of 22 rock samples. Based on the results, we developed a time-average equation with a lithology-dependent variable to compensate changes in matrix velocity (Draebing & Krautblatter, 2012).

(ii) We used the laboratory results for Steintaelli samples as a priori information for our field measurements. First arrivals were picked manually and traveltimes were plotted against source-receiver offset. Traveltimes resolve no distinct layers but p-wave velocities in the range of frozen rock samples. We tested different initial model velocities and selected the best model in terms of RMS and absolute time differences. Ray tracing was performed and ray density analyzed. Laboratory p-wave velocities were used to develop permafrost scenarios for the resulting SRTs (Krautblatter & Draebing, subm.).

(iii) Time-Lapse SRT was used to monitor monthly, annual and 5-year alterations of the thawing front. In 2006, the tomographies display ice-filled fractures and permafrost in depths of 4-8 m. Due to lateral onfreezing of glacierets and a persistent snow cornice, permafrost was obtained close to the surface in 2007. In 2012, the second warmest august since 2003 degraded permafrost to depths of 5-15 m.

Here we show, that p-wave refraction seismics is capable of measuring and monitoring permanently and seasonally frozen rocks in steep unstable high-alpine rock walls.

References:

Draebing, D. and Krautblatter, M.: P-wave velocity changes in freezing hard low-porosity rocks: a laboratory-based time-average model, The Cryosphere, 6, 1163-1174, doi:10.5194/tc-6-1163-2012, 2012.

Krautblatter, M. and Draebing, D.: Pseudo 3D – P-wave refraction seismic monitoring of permafrost in steep unstable bedrock, Journal of Geophysical Research – Earth Surface, submitted.