Geophysical Research Abstracts
Vol. 17, EGU2015-8831-2, 2015
EGU General Assembly 2015

Thermo-hydro-mechanical stresses during repeat glacial cycles as preparatory factors for paraglacial rock slope instabilities

Lorenz Grämiger (1), Jeffrey R. Moore (2), Valentin Gischig (1), and Simon Loew (1)

(1) Department of Earth Sciences, ETH Zurich, Switzerland (lorenz.graemiger@erdw.ethz.ch), (2) Geology & Geophysics, University of Utah, Salt Lake City, Utah

Glaciation and deglaciation contribute to stress redistribution in alpine valley rock slopes, generating rock mass damage. However, the physical processes contributing to slope instability during glacial cycles are not well understood, and the mechanical reasoning remains vague. In addition to glacier loading and unloading, thermal strains affect newly exposed bedrock while changes in hillslope hydrology modify effective stresses. Together these can generate damage and reduce rock slope stability over time. Here we explore the role of coupled thermo-hydro-mechanical (THM) stress changes in driving long-term progressive damage and conditioning paraglacial rock slope failure in the Aletsch glacier region of Switzerland. We develop a 2D numerical model using the distinct element code UDEC, creating a fractured rock slope containing rock mass elements of intact rock, discontinuities, and fault zones. Topography, rock properties and glacier history are all loosely based on real conditions in the Aletsch valley. In-situ stresses representing pre-LGM conditions with inherent rock mass damage are initialized. We model stress changes through multiple glacier cycles during the Lateglacial and Holocene; stress redistribution is not only induced by glacier loading, but also by changes in bedrock temperatures and transient hillslope hydrology. Each THM response mechanism is tied to the changing ice extents, therefore stress changes and resulting rock mass damage can be explored in both space and time. We analyze cyclic THM stresses and resulting damage during repeat glacial cycles, and compare spatiotemporal outputs with the mapped landslide distribution in the Aletsch region. Our results extend the concept of glacial debuttressing, lead to improved understanding of the rock mass response to glacial cycles, and clarify coupled interactions driving paraglacial rock mass damage.