Geophysical Research Abstracts
Vol. 18, EGU2016-18256, 2016
EGU General Assembly 2016

Preconditioning of the Eibsee rock avalanche by deglaciation and development of critical bedrock stresses

Kerry Leith (1,2), Felix Hofmayer (2), Barbara Kessler (2), and Michael Krautblatter (2)

(1) Geological Institute, ETH Zurich, Zurich, Switzerland, (2) Landslide Group/Engineering Geology,Technische Universität München (TUM), Munich, Germany

The impact of glacier retreat on rock slope instability since the Last Glacial Maximum is the subject of ongoing debate. Rock slope activity since ice retreat is typically attributed to increased kinematic freedom as a result of erosion during glaciation, debuttressing of valley walls which may have been supported by glacier ice, specific patterns of Holocene seismicity, or an exposure of rock slopes to increased chemical and biological weathering during the present interglacial. Here, rather than looking for a particular driver or trigger for rock slope instability, we evaluate the potential for rock mass degradation in response to an increase in tensile stress or micro-cracking in critically stressed near-surface bedrock (0 – 2 km depth). Instead of focusing on a specific driver, this allows us to identify regions in which fracture development is likely to be ongoing, and slope stability is therefore decreasing with time. Combining two orthogonal cross-sections, we evaluate stress changes and fracture development in the Zugspitze region of the Wetterstein Mountains (southern Germany) using an elasto-plastic 2-D FEM model (Phase2 from Rocscience). Based on geological evidence, we reconstruct the 3-D topography of the former Zugspitze peak, prior to what we estimate to be a 165 Mm3 collapse (previously dated at 3700 B.P.). We then impose initial stress conditions consistent with the tectonic and exhumation history of the region, as well as rock mechanical attributes derived from a fracture survey of the Zugspitzplatt and results of standard laboratory testing of Wettersteinkalk, the dominant lithology in the region. By imposing ice loading through a series of glacial-interglacial cycles, we are able to generate, and maintain critical stresses and low levels of fracture propagation beneath the Zugspitzplatt and at the location of the rock avalanche release throughout deglaciation, supporting our field observations. We then simulate weathering near the model surface by reducing cohesive strength until failure occurs at the location of the Eibsee rock avalanche. Although there is currently little to constrain a reduction of rock mass strength through time, the development of modelled critical tensile stresses consistent with linear karst features on the Zugspitzplatt, and modelled microcracking close to the failure surface of the rock avalanche indicate the avalanche was likely preconditioned by cyclic ice loading, and long-term bedrock strength degradation in association with critical stresses in the upper few hundred meters of the massif.