Geophysical Research Abstracts
Vol. 17, EGU2015-12496, 2015
EGU General Assembly 2015

The mobility of rock avalanches: disintegration, entrainment and deposition - a conceptual approach

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Massive rock slope failures cause more than 60% of all catastrophic landslide disasters. Failures usually progress through three consecutive phases: detachment, disintegration and flow. While significant advances have been achieved in modelling Rock Avalanche Phase 1 “Detachment” and Phase 3 “Flow”, the crucial link between both during Phase 2 “Disintegration”, is still poorly understood. Disintegration of the detached rock mass is often initiated by its first major impact with the ground surface. This is a preliminary setup of a PhD project in which we aim at understanding the importance of disintegration and on site conditions at the impact site on fluidization and mobilization.

The TUM Landslides Group is experienced in near surface geophysics of rockwalls and under Alpine conditions and has also developed laboratory experience in testing resistivity and P-/S-wave velocity of anisotropic and fractured rocks in the laboratory. In addition, there is a more than ten year experience in the analysis of different magnitudes of rock slope failure. Many of these studies took part in the Wetterstein Mountains and close to the Zugspitze.

In this project we plan to compare one very small (Steingerümpel, Rein valley, Germany, with 0.003 km^3) and two larger test sites (Eibsee, Zugspitze area, Germany, with 0.3 km^3 and Flims, Grisons, Switzerland, with 12 km^3) situated in limestone rocks. From our preliminary work we know that the Steingerümpel bergsturz shows a low degree of fracturing in spite of a high impact; the latter ones are high-magnitude rock slope failures which both partially collapsed into a lake and were highly disintegrated and fluidized. We intend to use the smaller Eibsee rock avalanche as a training site where we can try to understand the full dynamics of the flow using sedimentology, geophysics and surface geomorphology which indicated compressive and extensional flow, superelevation and runups. Regarding entrainment processes, we will carry out a seismic investigation of the Eibsee lake floor, assuming an impact of the Eibsee rock avalanche with a former paleo-lake, thereby entraining fine grained lake sediments. Furthermore, we apply these insights to the 12 km^3 large Flims rock avalanche which is also partly fluidized and partly highly disintegrated in limestone with similar geomechanical properties.

Here we demonstrate a conceptual approach for deciphering the disintegration impact on different magnitudes of rock avalanches. We want to show how they can be applied to constrain realistic flow models, and finally, how the latter can be used to better understand the mobilization and anticipation of highly mobile rock avalanches.