Characterization of a deep-seated rock slide in a glacier-retreat environment (Ötztal Valley, Austria)

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Deep-seated rock slides are widespread processes in Alpine valleys, particularly on slopes affected by glacier-retreat. The spatio-temporal evolution of these rock slides is influenced by various predisposition factors, such as topography, lithology, geological structures, in-situ-stresses, groundwater flow, glacier and permafrost degradation, and temperature fluctuations.

In this study failure and formation processes, and the deformation behaviour of a highly active deep-seated rock compound slide in a glacier-retreat environment, in the upper Ötztal valley (Tyrol, Austria) is investigated. The rock slide is located at the SE-facing slope above the Marzellferner valley glacier and measures about 400 m in width and 600 m in height (main scarp at 2850 m a.s.l.). Based on historic and remote sensing data from 1893 onwards, the toe of the valley glacier has retreated approx. 2 km and has lost of more than 150 m of its thickness. GPS and tachymetric survey campaigns initiating in 2012 show a high actual activity of the slide i.e. reaching annual rates of several decimetres per year and indicate a temporal relationship between the glacier retreat and the rock slide activity.

Geologically, the rock slide is situated in the metamorphic units of the Ötztal Crystalline of the Upper Austroalpine Nappe System and is composed of paragneisses, mica-schists and banded amphibolites. Geological structures (e.g. foliation planes, joints, brittle fault zones) influence the failure geometry and the kinematics of the rock slide. Distinctive geomorphological features, i.e. primary and secondary scarps, uphill and downhill facing scarps, horst and graben and structures, as well as trenches and tension fractures indicate a complex failure and deformation process of the rock slide, characterised by zones of internal extension and compression. Based on an extensive field survey campaign, geomorphological and geological structures were mapped in order to develop a geometrical, kinematical and geomechanical model of the rock slide. In addition, deformation monitoring data were analysed to distinguish between individual rock slide slabs of variable activity and to study the influence of the Marzellferner glacier retreat on the rock slide velocity.