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Glacial Debutressing and Displacement History of the Driest Rockslide (Central Alps, Switzerland)

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Only few studies have been performed, where the physical interactions between a retreating valley glacier and rock slope movements have been recorded and analyzed in detail. The Driest landslide, situated at the current tongue of the Great Aletsch Glacier in the Swiss Alps, offers a unique case study, because the history of the Great Aletsch Glacier has been studied in great detail by various researchers and the Driest landslide displacements can be unraveled for similar time windows. In this paper we focus on the most recent observation period, i.e. the rockslide and glacier history since the Little Ice Age, when the entire Driest landslide was covered by the glacial ice.

Our kinematic model of the Driest landslide, based on field mapping and photogrammetric analyses, was confirmed by displacement vector data from two robotic total stations recording daily displacements of 12 reflectors positioned within the instability. The rockslide basal rupture plane is a compound sliding surface composed of a steeply dipping head scarp, a presumably moderately steep central section, and an upward directed daylighting frontal section. This rupture plane geometry is structurally conditioned by a regional fault in the head scarp area and a rotating Alpine foliation in the toe area.

The most recent displacement history of this old rotational rockslide has been unraveled by lichenometry (i.e. systematic mapping of greenish Rhizocarpon Geographicum diameters) in the deepest part of the head scarp, calibrated with dendrochronologic data. Depending on the lichen profile position within the head scarp area, different displacement time histories of the Driest landslide can be developed and correlated with glacial ice elevations as recorded by multiple aerial images and historical documents. Whereas displacement rates before 1991 were in the order of 1 cm/year, significantly higher displacement rates ranging between 7 and 13 cm/year are recorded in the head scarp area for the period between 1991 and 2010. These accelerated displacements correspond exactly to the time, when the Aletsch glacier elevation dropped below the daylighting basal rupture plane. This implies that also small glacial loading of the landslide toe significantly reduces displacement rates.

Very similar observations can be made on the opposite side of the glacier, where strong accelerations were recorded exactly at the location and time, when the ice completely retreated from the landslide toe. This supports the hypothesis, that very small changes in the static loading conditions of mature rock slope instabilities cause disproportionate reactions. These conditions have also been explored and confirmed with numerical models taking into account long-term damage from glacier retreat since the Egesen stadial and impacts of pore pressure variations below the temperate Great Aletsch Glacier.