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The Geomorphological Evolution of a Landscape in a Tectonically Active Region: the Sennwald Landslide

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The Säntis nappe is a fold-and-thrust structure in eastern Switzerland consisting of numerous tectonic discontinuities that make rocks vulnerable to rock failure. The Sennwald landslide is one of those events that occurred due to the failure of Lower Cretaceous Helvetic limestones. This study reveals the surface exposure age of the event in relation to geological and tectonic setting, earthquake frequency of the Central Alps, and regional scale climate/weather influence. Our study comprises detailed mapping of landform features, thin section analysis of landslide boulder lithologies, landslide volume estimation, numerical DAN-3D run-out modelling, and the spatial and temporal relationship of the event.

In the Sennwald landslide, 92 million m3 of limestones detached from the south-eastern wall of the Säntis nappe and slid with a maximum travel distance of ∼4'500 m and a "fahrboeschung" angle of 15° along the SE-dipping sliding plane almost parallel to the orientation of the bedding plane. Numerical run-out modelling results match the extent and the thickness of landslide deposits as observed in the field. The original bedrock stratigraphy was preserved as geologically the top layer in the bedrock package travelled the farthest and the bottom layer came to rest closest to the release bedrock wall during the landslide. Velocities of maximum 90 m/s were obtained from the numerical run-out modelling. Total Cl and 36Cl were determined at ETH AMS facility with isotope dilution methods defined in the literature (Ivy-Ochs et al., 2004). Surface exposure ages of landslide deposits in the accumulation area are revealed from twelve boulders.

The distribution of limestone boulders in the accumulation area, the exposure ages, and the numerical run-out modelling support the hypothesis that the Sennwald landslide was a single catastrophic event. The event is likely to have been triggered by at least light to moderate earthquakes (Mw=4.0-6.0). The historical and the last 40-year earthquake activity shows that this region is tectonically still active (Mosar, 1999) with numerous earthquakes. The exposure ages imply that the rock failure occurred during the middle Holocene, a period of increased neotectonic activity in Eastern Alps suggested by Prager et al. (2007). This time period also coincides with notably wet climate, which has been suggested as an important trigger for landslides around this age across the Alps (Zerathe et al., 2014).