



## **Schmidt-hammer exposure-age dating (SHD) on periglacial and paraglacial landforms in the south-western fjord area of Norway: Indications of Holocene climate variability**

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Schmidt-hammer exposure-age dating (SHD) was carried out on various talus derived periglacial and paraglacial landforms around Dalsnibba (1476 m a.s.l.) in proximity to the Geiranger fjord in Opplandskedalen. The investigated landforms comprise amongst others rock-slope failures and pronival ramparts. The ages of landforms are critical in terms of understanding the timing of geomorphic processes, explaining landscape evolution and comprehending the temporal connectivity between Holocene climatic variability and landform development. Nonetheless, landform ages often remain ambiguous. In addition, there is no Holocene climatic record available for Opplandskedalen. From young and old control points of known age from terrestrial cosmogenic nuclide dating, we constructed a high-precision calibration curve to accurately estimate landform ages. In this study we aim to relate time of landform formation and stabilization to climatic variability in the Holocene and to assess the often stated assumption that periglacial and paraglacial landforms are geomorphic fingerprints of cold climate events. The estimated SHD ages, with 95% confidence intervals, range from  $4485 \pm 414$  to  $1336 \pm 288$  years. The negative skewness of all landforms indicates that more weathered boulders incorporated into the population and that the real ages of the landforms stabilization are older. The frequency distributions point to the fact that most studied landforms point to the fact that they mostly stabilized during a single event. All landforms stabilized in different cold phases following the Holocene Thermal Maximum, which were described in Jotunheimen. Another possible trigger for rock-slope failures is the occurrence of earthquakes in the area. In the research area, these ages are the first indications of the presence of these cold events. In conjunction with ages from other studies in the eastern part of southern Norway it appears that maritime climate leads to more sensitive morpho dynamic response of landforms.