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Pleistocene evolution of a Scandinavian plateau landscape

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The origin and Pleistocene evolution of high plateau landscapes along the passive North Atlantic continental margins have been debated for more than a century. It has been suggested that the plateaus represent relict landscape elements formed under warm climate conditions prior to the inception of glaciations, and some studies relate the plateaus to late-Cenozoic vertical displacements of former fluvial base levels. According to these hypotheses, Pleistocene ice sheets eroded deep glacial troughs, but left the overall plateau morphology between the troughs unchanged. However, this view is challenged by recent studies showing that climatically controlled surface processes may explain the origin and spatial distribution of the plateaus (Egholm et al. 2015, Egholm et al. 2017).

Here, we derive erosion rates across a prominent plateau landscape in Reinheimen National Park in southern Norway via inverse modelling of 141 new cosmogenic ^{10}Be and ^{26}Al measurements of bedrock and regolith. We combine these results with geomorphological mapping and sedimentological analyses of the regolith.

Erosion rates vary between $\sim$4 and >30 m Myr^{-1}, indicating that the landscape is eroding unevenly. The combination of erosion rates <10 m Myr^{-1} and a broad, convex shape of the land surface in the vicinity of the summits indicates long-term equilibrium with the presently active periglacial hillslope processes. Outside summit areas, both regolith-covered and bare-bedrock sites are eroding faster (up to >30 m Myr^{-1}), possibly as a result of periodic glacial erosion.

Sedimentological analyses show the regolith in Reinheimen is mainly formed by physical weathering. Despite some indications of chemical weathering, such as grussic saprolite development, primary minerals dominate the fine matrix, clay/silt ratios are low, and primary mineral grains do not show signs of chemical weathering, such as dissolution-related etching and pitting. Together with the modelled erosion rates, this indicates that the regolith formed, and continues to develop, during recent cold-climate conditions.

Egholm, D. L., Andersen, J. L., Knudsen, M. F., Jansen, J. D., Nielsen, S. B. (2015). The periglacial engine of mountain erosion-Part 2: Modelling large-scale landscape evolution. Earth Surface Dynamics, 3(4).

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