Geophysical Research Abstracts
Vol. 17, EGU2015-13424, 2015
EGU General Assembly 2015

Cirque-driven erosion of the Scandinavian mountains

John D. Jansen (1,2,4), Alexandru T. Codilean (2), David L. Egholm (3), Mads F. Knudsen (3), Oliver Korup (1), Arjen Stroeven (4), Bradley Goodfellow (5), Jane L. Andersen (3), Sofie V. Ugelvig (3), and Josefin Klein (4)

(1) Institute of Earth & Environmental Science, University of Potsdam, Germany (john.jansen@uni-potsdam.de), (2) School of Earth & Environmental Sciences, University of Wollongong, Australia, (3) Department of Geoscience, Aarhus University, Denmark, (4) Department of Physical Geography, Stockholm University, Sweden, (5) Department of Geological Sciences, Stockholm University, Sweden

Climatic versus tectonic explanations for Scandinavian topography have sustained a century-long dispute. Here, at high-latitudes, the more recent question of whether Late-Cenozoic cooling has influenced mountain erosion rates is especially apt because glaciations commenced earlier: >10 Myr and possibly ∼34 Myr according to marine palaeorecords. Although selective glacial incision along valley troughs is well recognised in Scandinavia, the legacy of glacial cirque erosion has yet to be fully investigated.

We examine the topographic legacy of mountain glaciation in seven massifs of the Caledonian Scandes (western Scandinavia ∼61–70° N): Lyngen, Kebnekaise, Sarek, Saltfjellet, Dovrefjell, Jostedalsbreen, and Jotunheimen. Glacial cirques are the product of discrete alpine glaciers and so the elevation of ice-free cirques provides a guide to past fluctuations in regional equilibrium line altitude (ELA). The Scandes currently hosts >3400 mountain glaciers and the distribution of >10,000 ice-free cirques indicates that glaciers have extended much lower and farther in the past. Previous workers argue that alpine glaciations focus erosion selectively at and above a zone of cirques, which approximates the long-term average 'palaeo-ELA'.

First, we set out to examine the topographic relationships between mountain peak elevation, ELA, cirque-floor elevations, and the distribution of low-slope (<10°) terrain. To estimate the regional ELA for each massif, inclined planar trend-surfaces (first-order polynomial) were fitted to median elevations of existing glaciers. A total of ∼4000 ice-free cirques were mapped and plotted relative to the ELA surfaces. For all seven massifs, cirque-floors cluster within a discrete elevational range: 240–490 m (25–75th percentiles) below ELA, suggesting a well-defined 'palaeo-ELA'. Hypsometric analyses show that this 'palaeo-ELA' closely matches the maximum frequency of low-slope terrain. Consistent with studies elsewhere, terrain surface area declines exponentially above modern ELA (4–13% in total) and peaks protrude <800 m.

Second, topographic analysis was conducted via 50 km-wide latitudinal swaths spanning the entire mountain belt. Maximum peak elevations and mean elevations both dip northward at 0.48 m/km and 0.34 m/km, respectively. These compare with the overall ELA northward dip at 0.55 m/km, and the maximum frequency of low-slope (<10°) terrain also dipping northward at 0.57 m/km — all suggesting a zonal control on topography that is compatible with a climate-driven origin.

These results confirm conclusions from other studies suggesting that alpine glaciation can exert first-order control on topography at mountain belt-scale. We reflect upon the possible genetic links between widespread mountain plateaux, the elevation of cirque floors, and mountain peaks; namely, the erosional processes involved in generating a cold-climate topographic signature in postorogenic mountains.