Geophysical Research Abstracts
Vol. 20, EGU2018-17330, 2018
EGU General Assembly 2018

Glacial erosion and relief production on gneiss-granite plateaus

David L Egholm (1), John D Jansen (1), Vivi K Pedersen (2), Henriette Linge (2), Miriam Dühnforth (3), Jane L Andersen (1), Bo H Jacobsen (1), Daniel Skov (1), and Mads F Knudsen (1)

(1) Aarhus University, Department of Geoscience, Aarhus, Denmark, (2) University of Bergen, Department of Earth Science, Bergen, Norway, (3) LMU Munich, Department of Earth and Environmental Sciences, Munich, Germany

The great northern hemisphere Plio-Pleistocene ice sheets repeatedly covered extensive low-relief bedrock terrain composed of hard and relatively resistant gneiss and granite (Krabbendam & Bradwell, 2014). Today, many of these landscapes are high above sea level, forming mountain plateaus separated by deep glacial troughs and fjords (Sugden & John, 1976).
Bedrock structure clearly inserts dominant control on the topographic relief of the plateaus. The highest areas typically expose relatively massive, glacially-abraded bedrock, whereas topographic lows correspond to intersecting fractures and rock basins that show signs of glacial quarrying (Krabbendam & Bradwell, 2014). However, the depth of glacial erosion in such terrain has been long debated, and it is difficult to constrain. Given that very similar-looking topography also exists in non-glaciated gneiss terrain, there does not seem to be a unique topographic signature of glacial erosion on mountain plateaus. Indeed, some suggest that the bedrock topography primarily reflects patterns of pre-glacial chemical weathering, and that ice sheets removed no more than the surface mantle of regolith and weathered bedrock (e.g. Lidmar-Bergström, 1997, Krabbendam & Bradwell, 2014).
We combined cosmogenic nuclide measurements with computational modeling to study the patterns and rates of glacial erosion in a typical gneissic plateau landscape south of Lysefjorden, southern Norway. We were particularly interested to see whether topographic highs and lows show a systematic distribution of nuclide inheritance. Measurements of 10Be and 26Al concentrations in 26 bedrock samples show that nuclide inheritance is limited and almost randomly distributed in the landscape. Markov-chain Monte Carlo modeling of the cosmogenic nuclide concentrations suggests that erosion over the last few glaciations has entailed efficient, but stochastic, quarrying of blocks combined with continuous, but inefficient, surface abrasion.
It is hard to imagine that glacial erosion was largely limited to removal of in-situ weathered regolith, especially when extrapolating the CN results across all Plio-Pleistocene glaciations. In stead, we used computational landscape-evolution experiments to study how glacial erosion might have formed the present bedrock topography. These experiments indicate that heterogeneity of bedrock strength in combination with subglacial hydrology provide the main controls on landscape evolution in these terrains.

Krabbendam, M., Bradwell, T., 2014. Quaternary evolution of glaciated gneiss terrains: pre-glacial weathering vs. glacial erosion. Quaternary Science Reviews 95, 20-42.

Lidmar-Bergström, K., 1997. A long-term perspective on glacial erosion. Earth Surf. Process. Landf. 22, 297-306.

Sugden, D.E., John, B.S., 1976. Glaciers and Landscape: a Geomorphological Approach. Arnold, London.