

Erosion of low-relief basement by the Fennoscandian ice sheet based on bedrock ^{10}Be and ^{26}Al

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Glacial erosion can be intensive and it has created some of the most dramatic landscapes on Earth. Estimated glacial erosion rates range over multiple orders of magnitude, with very low erosion evidenced by preservation of landforms under non-erosive ice and high erosion illustrated by deeply carved fjords and by sediment output from present-day glaciers. Most glacial erosion estimates are derived from high-relief mountainous landscapes and their glaciers. Ice sheets that covered North America and northern Eurasia during the Quaternary covered low-relief topography and it is the erosional imprint of these ice sheets on low-relief landscapes that is the focus of our study.

To investigate glacial erosion of low-relief topography under large ice sheets we have measured ^{10}Be and ^{26}Al in 32 bedrock samples from the east coast of Sweden. These samples are derived from a low-relief (0-70 m a.s.l.) crystalline basement region around Forsmark with well-constrained timing and rates of deglaciation and isostatic rebound. Simple exposure ages range from 2 to 71 ka. Taking the shielding by water due to isostatic rebound into account, all samples but one have ^{10}Be and ^{26}Al concentrations higher than commensurate for deglaciation, with most samples being 3.5-10 ka too old. This cosmogenic inheritance due to prior exposure enables us to explore model space for past glacial erosion. Tracking the cosmogenic nuclide production rate over time and depth, we simulate the buildup of ^{10}Be and ^{26}Al under a range of scenarios with varying ice cover durations, subaerial erosion rates, and modes of glacial erosion (constant erosion rate or constant erosion depth for each ice cover period). Under these assumptions and if excluding one sample, the simulations yield Quaternary glacial erosion lower than 0.4 m/ka or 3.3 m per ice cover period. For most of the samples for which we yield a solution for both ^{10}Be and ^{26}Al , glacial erosion was restricted to 0.04-0.09 m/ka or 0.4-1.1 m per ice cover period. For the last glaciation (last 100 ka), this translates into a total erosion of only 1.6-3.5 m. A comparison with previously published ^{10}Be and ^{26}Al data from bedrock samples in low-relief regions of Fennoscandia lends support to limited glacial erosion, with a large number of samples displaying cosmogenic inheritance. Our data and analysis show that the glacial erosion rate of the low-relief landscape under the last Fennoscandian ice sheet may be significantly lower than common glacial erosion rates in alpine regions.