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Deciphering Greenland Icesheet history and process over millions of years using cosmogenic nuclides

Measurements of cosmogenic nuclides in bedrock, boulders, glacial, fluvial and marine sediment, silt embedded in basal ice, and ice-bound cobbles allow better understanding of the history and erosive capacity of the Greenland Ice Sheet. Together, these measurements reveal an ice sheet that is in some places dynamic and erosive but in other places so ineffective at eroding the bed that hundreds of thousands of years of history are preserved in rock and sediment both outside and inside the current ice margin. The age of surfaces exposed outside the ice margin varies. Cosmogenic nuclide measurements in samples collected from boulders and bedrock surfaces in central-western and northwestern Greenland, demonstrate that ancient, perhaps pre-glacial landscapes survived beneath the ice. Multigenerational landscapes dominate the uplands outside today's ice margin while many of the lowlands have been more deeply eroded. In southern Greenland, measurements of ^{10}Be and ^{26}Al show that erosion dominates; additional cosmogenic nuclide measurements there in bedrock and beach cobbles inform our understanding of when ice last melted away and isostatic uplift lowered relative sea level. Measurements of ^{10}Be in material collected during GISP2 ice coring, including silty basal ice and sub-ice bedrock, when taken at face value, appear contradictory but the discrepancy can be resolved by assuming early and limited exposure of bedrock below the GISP2 coring site and the preservation of silty basal sediment because of limited erosivity under ice frozen to the bed. The offshore record, ^{10}Be preserved in quartzose marine sediments, hints at the erosion and exposure history of the ice sheet over the past 7.5 My clearly showing the power of the ice sheet to strip pre-existing regolith. The marine sediment record indicates the ice sheet has been dynamic over time, changing where, when, and how deeply it erodes the landscape in response to a changing climate since the Pliocene.

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