Title:

When did the ice leave Upernavik and how much rock was eroded: first *in situ* cosmogenic ^{10}Be measurements from Northwestern Greenland

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Documenting the past behavior of the Greenland Ice Sheet is critical to understanding its future. To determine how effectively the ice sheet eroded bedrock and when the ice last melted away from Northwestern Greenland, we measured *in situ* cosmogenic ^{10}Be in paired bedrock and boulder samples collected outside of the present-day ice margin, as well as in 20 cobbles removed directly from active ice. The concentration of ^{10}Be is proportional to the time that a sample has been exposed, uncovered by ice.

We collected 20 bedrock and 14 boulder samples in a transect stretching from the sea to the present-day ice margin, at elevations between 30 and 1000 m. Boulder exposure ages cluster tightly around 11 ka, providing a best estimate for the timing of deglaciation near Upernavik. Bedrock samples show a strikingly different pattern suggesting that all 20 bedrock samples contain ^{10}Be left over from previous periods of exposure. Cumulative probability analysis shows a cluster of 7 bedrock ages around 14 ka, but two thirds of the bedrock samples have higher model exposure ages, up to 90 ka. Generally, bedrock samples high in ^{10}Be are from higher elevations and/or near the present-day ice margin. This suggests that high-latitude (and especially high-elevation) Pleistocene ice was only weakly erosive and failed to remove ^{10}Be from previous periods of exposure.

To investigate inherited ^{10}Be from a different perspective, we sampled icebound cobbles from near Kangerlussuaq (67°N), Ilulissat (69°N), and Upernavik (72°N). Unlike the high amount of inheritance observed in bedrock, these cobbles show small but consistent amounts of ^{10}Be, implying hundreds of years of surface exposure. Ice must have retreated enough during some previous interglacial period to expose these cobbles to cosmic radiation; however, this exposure was either short in duration or the cobbles were sourced from deeply eroded bedrock.

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