

## **Cosmogenic isotopes and the interpretation of Greenland's long-term weathering history**

Paul Bierman and Lee Corbett, University of Vermont

Jeremy Shakun, Boston College

In and around Greenland, cosmogenic nuclides, primarily Be-10 and Al-26, have been measured in samples from presently-exposed surfaces that were once glaciated, from surfaces under the ice sheet, and in sediment eroded from and transported away from these surfaces. Such sediment is carried by glaciers and outwash streams, stored as fjord-bottom sediments, moved onto the shelf, and eventually deposited offshore where it accumulates and can be recovered, providing a record of cosmogenic nuclide concentrations in the past. Such data have been interpreted, through the use of forward models, as both a record of past erosion and past exposure histories.

Isotope analyses clearly indicate that some parts of the Greenland Ice sheet (GIS) have effectively eroded the bed, reducing cosmogenic nuclide concentrations to at most a few thousand atoms/g, the equivalent of only hundreds of years of surface exposure. These low concentrations likely result from interglacial exposure to deeply penetrating muons through tens of meters of rock; some residual nuclides could even predate the expansion of the GIS at the dawn of the Pleistocene. In other areas, high concentrations of both Be-10 and 26-Al indicate minimal erosion and long periods of burial – the result of cold-based ice, frozen to the bed, subglacially preserving the landscapes it overran.

Today, most sediment transported by the ice and moving through outwash streams contains scant Be-10 and 26-Al, suggesting it was sourced from erosive, warm-based areas of the ice sheet's bed. Cosmogenic analyses of marine sediment cores around Greenland indicate that this was not always the case. Early in the records, before the Pleistocene, decay-corrected Be-10 concentrations were much higher and then lowered over time, suggesting the progressive stripping of pre-glacial regolith. Ratios of Al-26/Be-10 vary but are higher than would be expected had ice cover been continuous. Together, these data suggest a persistent but dynamic Greenland Ice Sheet which retreated during at least some interglacial periods to expose sediment source areas to cosmic radiation.

Significant issues remain in the interpretation of nuclide concentrations in marine sediment cores including: 1) Unknown lag time from ice sheet transport to deposition off shore, 2) the need for masses of sandy material sufficient to extract 20-40 grams of pure quartz from short core intervals in order to optimize analytical precision and accuracy without blurring the record, 3) well-defined age models for cores, and 4) better constraint on sediment source areas. A high accumulation rate drill site that preserved sediment from several well-dated terminations and had a well-defined source area would allow much less ambiguous interpretation of the cosmogenic record in marine sediment in terms of ice sheet history and process.