IMPLICATIONS FOR SEA LEVEL CHANGE OVER THOUSANDS TO MILLIONS OF YEARS – TRACING GREENLAND 'S ICE USING COSMOGENIC NUCLIDES

Bierman, Paul R.; Corbett, Lee B; and Shakun, J.
University of Vermont and Boston College

Over the past decade, we and others have made measurements of cosmogenic nuclides in samples of bedrock outcrops, glacial, fluvial and marine sediment, basal ice, and ice-bound cobbles. Together, these measurements, now numbering many hundreds, reveal a Greenland ice sheet that is in places dynamic and erosive but in other places is so ineffective at eroding the bed that many hundreds of thousands of years of history are preserved in rock and sediment. The history of ice on Greenland is also the history of that ice's influence on sea-level both directly and through glacial isostatic adjustments.

Knowing where and how deeply the ice has eroded the landscape is a critical limit on the utility of cosmogenic dating techniques. For example, in northern Greenland, ancient landscapes dominate the uplands outside today's ice margin while some of the lowlands have been more deeply eroded. In southern Greenland, erosion dominates and cosmogenic nuclide measurements can be used to inform better our understanding of when ice last melted away. We have relied on such deep erosion to interpret ^{10}Be measurements in coastal outcrops as rates of emergence in the several thousand years just after deglaciation as well as during the middle Holocene.

Measurements of ^{10}Be in rock and silt extracted from the base of the GISP2 ice core are together most consistent with early and limited exposure of bedrock below the GISP2 coring site. The preservation of silty basal sediment must result from limited erosivity under ice that is dominantly frozen to the bed. But, these data are permissive of loss of ice below the GISP2 site at major interglacials, albeit brief.

The offshore record, preserved in marine sediments now analyzed for ^{10}Be at 4 different sites, reveals the history of the Greenland ice sheet over the past 7.5 My, clearly showing the power of ice to progressively strip pre-existing regolith from some parts of the landscape. The marine record preserves the history of erosion and indicates the icesheet has been dynamic over time, changing where, when, and how deeply it erodes. Comparison of Greenlandic marine core data with data from the Laurentide and Antarctic Ice Sheets demonstrates the stability of Antarctic ice cover the Pleistocene, a mostly absent Laurentide Ice Sheet, and a dynamic ice sheet covering and uncovering Greenland and thus yo-yoing sea level over time. The timing and magnitude of changes in ice volume are not yet directly interpretable from marine ^{10}Be records.