A 7 Myr record of Greenland glaciation and erosion from in situ 10Be in marine sediments

Details

Meeting	2013 Fall Meeting
Section	Cryosphere
Session	Climate Change and Cryospheric Systems III (Virtual Option)
Identifier	C31C-08
Authors	Shakun, J*, Earth and Environmental Sciences, Boston College, Chesnut Hill, MA, USA Bierman, P R, Geology, University of Vermont, Burlington, VT, USA
Index Terms	Ice sheets [0726]

Abstract

New in-situ-produced 10Be data provide the first isotopic record of the long-term growth and erosion history of the Greenland Ice sheet. Continental sediment typically contains >100,000 atoms/g of in-situ produced 10Be, the result of exposure to cosmic rays, primarily neutrons which penetrate only a meter or two into rock and soil. Once Earth's surface is covered by glacial ice, 10Be production ceases and glacial erosion removes the most highly-dosed, near-surface material first before excavating material at depth containing progressively less 10Be. Marine sediments preserve material shed from the continents over time. Using 30 in situ 10Be samples from ODP site 918 off southeast Greenland, we have developed a record of Greenland Ice Sheet development and erosion. Our record spans approximately the past 7 Myr and begins when ice rafted glacial debris first appears at this site. We use the core age model to decay-correct measured 10Be concentrations to the concentration at the time of deposition. The 10Be record is dominated by a long-term decline in 10Be concentration from 170,000 atoms/g at 7 Ma to as low as 4,000 atoms/g during the late Pleistocene, which we interpret as reflecting the transition from a primarily ice-free to ice-covered Greenland and the continuing removal, over time, of Tertiary regolith and bedrock containing high levels of 10Be. Several shorter-lived peaks are superimposed on this long-term trend, most notably a brief spike to near pre-glacial levels (160,000 atoms/g) at ~2.5 Ma. We suspect that the decline in 10Be from ~7 to 2.5 Ma records growth of small ice caps or ice sheets, while the spike at 2.5 Ma represents initial development of a full Greenland Ice Sheet at the onset of the Quaternary - coincident with the first appearance of continental ice around the Northern Hemisphere. A step-like decrease in 10Be occurs at ~900 ka, from early Pleistocene values centered on ~30,000 atoms/g to ~8,000 atoms/g during the late Pleistocene. This step may reflect the final stripping of regolith and a switch to bedrock erosion. The timing of this shift in basal substrate, if it also occurred in North America, is consistent with the Regolith Hypothesis for the mid-Pleistocene transition from 41 to 100-kyr glacial cycles, which posits that thinner, more responsive ice sheets sliding on regolith transitioned to larger, more sluggish ice sheets resting on bedrock. Lastly, 10Be values over the past 900 kyr are similar to those in sediments issuing from the western, southern, and eastern Greenland Ice Sheet margin today, consistent with the existence of a large, modern-like Greenland ice sheet for most of that time. Inverting the 10Be data from the beginning of the record at 7 Ma and assuming that the sediment delivered

to the deep ocean was stripped from the surface of Greenland at an elevation near sea-level suggests a landscape averaged Tertiary denudation rate of about 20 m/My, lower than basin-scale rates for polar climates but higher than rates of outcrop erosion compiled by Portenga and Bierman (2011).

Cite as: Author(s) (2013), Title, Abstract C31C-08 presented at 2013 Fall Meeting, AGU, San Francisco, Calif., 9-13 Dec.
