Cosmogenic Isotopic Tracing of Sediment Generated By the Greenland Ice Sheet

Details

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Abstract

Ice sheets can be powerful agents of erosion or preserve frozen landscapes. Here, we use cosmogenic Be-10 and Al-26, produced in situ in rock and regolith, and meteoric Be-10 produced in the atmosphere and delivered by precipitation, to trace the source and understand the history of sediment leaving the Greenland Ice Sheet. Measurements of both in situ and meteoric Be-10 constrain processes at the base of the ice sheet over space and time. Outcrops around the ice sheet margin have widely varying Be-10 content, indicating that some areas were covered and preserved by non-erosive, cold-based ice, frozen to the bed, while other areas were scoured by erosive, warm-based ice. Silty ice at the bottom of the GISP2 core preserves high concentrations of meteoric Be-10 in what is likely an ancient soil, indicative of long-lived, cold-based ice in the center of Greenland. Sediment samples from outwash streams, moraines, and drainages originating in deglaciated areas around the southwestern, southern, and southeastern margin of Greenland generally have low concentrations of in situ Be-10 (thousands to a few tens of thousands of atoms/g) and Al-26/Be-10 ratios similar to that of surface production (~7). Such ratios and concentrations of Be-10 indicate this sediment is sourced from areas that were deeply eroded by warm-based ice and likely re-exposed during the mid-Holocene warm period. Quartz extracted from a marine core off southeastern Greenland (ODP-918) shows the progressive stripping of preglacial Pliocene regolith and an overall 100-fold decrease in decay-corrected Be-10 concentration over time. After the mid-Pleistocene change to 100 ky climate cycles, Be-10 concentrations are within the range of those measured in sediment currently issuing from the ice sheet indicating a similar history and source. Al-26/Be-10 ratios in core sediment from the past 2 My show that during some times, Greenlandic sediment delivered to the ocean comes from areas where it has been buried by ice for hundreds of thousands of years before export (Al-26/Be-10 ratios

<7); at other times, Al-26/Be-10 ratios show that sediment has recently been exposed to cosmic radiation (Al-26/Be-10 ~7), most likely during periods when the ice sheet was substantially reduced. Subglacial erosion is clearly heterogeneous over space and time.

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