2011 GSA Annual Meeting in Minneapolis (9–12 October 2011)

Paper No. 82-9

Presentation Time: 10:20 AM-10:35 AM

ANCIENT, SLOWLY-ERODING SOIL PRESERVED BENEATH THE SUMMIT OF THE GREENLAND ICE SHEET

BIERMAN, P.[1], CORBETT, Lee B.[2], FINKEL, Robert[3], GRALY, Joseph A.[4], HUGHES, John[2], LINI, Andrea[5], NEUMANN, Thomas A.[6], and ROOD, Dylan[7], (1) Geology and School of Natural Resources, University of Vermont, Delehanty Hall, 180 Colchester Ave, Burlington, VT 05405, pbierman@uvm.edu, (2) Department of Geology, University of Vermont, Delehanty Hall, 180 Colchester Ave, Burlington, VT 05405, (3) Center for Accelerator Mass Spectrometry, Lawrence Livermore National Laboratory, MS L-397, 7000 East Avenue, Livermore, CA 94550-9234, (4) Department of Geology and Geophysics, University of Wyoming, 1000 University Ave, Laramie, WY 82071, (5) Geology, University of Vermont, 180 Colchester Ave, Burlington, VT 05405, (6) NASA Goddard Space Flight Center, Cryospheric Sciences Branch, Code 614.1, 8800 Greenbelt Road, Greenbelt, MD 20770, (7) Center for Accelerator Mass Spectrometry, Lawrence Livermore National Laboratory, Livermore, CA 94550-9234

Cores that extend to the bed of ice sheets contain sediment-rich basal ice zones. In order to constrain better the source and character of sediment in the lower meters of the 3053-m long GISP2 ice core (the “silty ice zone”), we measured the concentration of meteoric ^{10}Be, organic carbon, and nitrogen in sediment separated from 17 core samples. The samples represent a total of 3 m of ice including an 11 cm section directly above the bed.

Meteoric ^{10}Be is a cosmogenic isotope formed in the atmosphere and delivered to Earth’s surface by precipitation and dry fall. It is an excellent tracer of sediment exposed to pedogenic processes; high concentrations of meteoric ^{10}Be are indicative of soil and sediment originating within several meters of Earth’s surface. Organic carbon and nitrogen are also markers of soil formation.

Silt in the lowermost 6.5 m of the GISP2 ice core has high concentrations of meteoric ^{10}Be (0.6 to 3.8 x 10^8 atoms/g), significant percentages of organic carbon (0.3 to 1.7%), and an average C/N ratio of ~10, all consistent with derivation from a well-developed, cold-region soil. The highest concentrations of meteoric ^{10}Be and TOC were measured in the bottom-most ice sample. The ^{10}Be concentration is consistent with a soil inventory >10^{10} atoms/cm^2 implying a soil exposure time >10^5 years before the soil was covered by ice. As Pleistocene interglacial periods were all short (<10^4 year) and few, if any, exposed the bed under GISP2, meteoric ^{10}Be data imply the preservation of soil formed during pre-Quaternary interglacial exposure. Concentrations of meteoric ^{10}Be and total organic carbon co-vary and decrease with distance from the bed, a trend consistent with other data suggesting that the underlying soil is mixed, by ice deformation, with rock flour derived from bedrock erosion elsewhere.

The GISP2 core location has likely been ice covered, with the possible exception of a short (4-7 ky) exposure at MIS 11 (Nishiizumi et al., 2006), since 2.5 Mya (Larsen et al., 1994), providing a minimum limiting age for the paleosol underlying Summit, Greenland. The continued existence of this ancient soil indicates extremely low rates of sub-ice erosion at GISP2. Survival of the soil for several million years under the Greenland Ice Sheet is consistent with the ice at Summit having been frozen to the bed for most, if not all, of the Quaternary.

2011 GSA Annual Meeting in Minneapolis (9–12 October 2011)
General Information for this Meeting

Session No. 82
Processes of Subglacial Erosion, Sediment Transport, and Deposition
Minneapolis Convention Center: Room L100DE
8:00 AM-12:00 PM, Monday, 10 October 2011

Geological Society of America *Abstracts with Programs*, Vol. 43, No. 5, p. 217