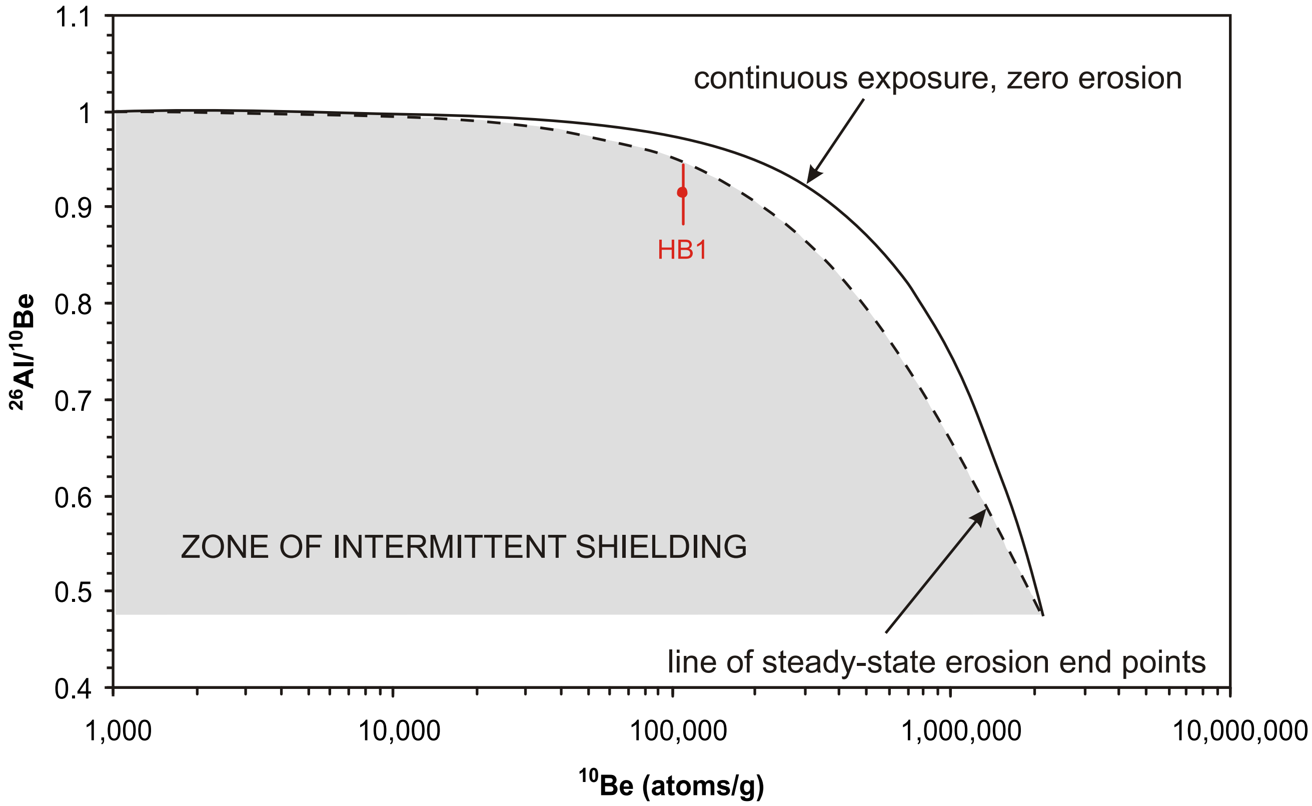

Figure DR1. Two isotope (^{10}Be vs. ^{26}Al/^{10}Be) diagram showing bedrock sample from Hunt Bluff (HB1), normalised to sea level and high latitude. The 'erosion island' is the area bounded by the solid line for continuous exposure, zero erosion and the dashed line of steady-state erosion end points. Data are normalised to unit production. Errors are 1σ; ^{10}Be error is less than the width of the symbol.

Figure DR1
Johnson et al

Table DR1: Sample and site description

Sample	BAS#[$]	Location	Latitude (S)	Longitude (W)	Elevation (m a.s.l.)	Elevation of adjacent ice (m a.s.l.)	Sample type	Lithology
TR1	R5.403.1	Turtle Rock, 12m below summit	75º 22.141	111º 17.945	700	366; Pope Glacier	erratic boulder	gneiss
TR2	R5.404.1	Turtle Rock, south-facing slope	75º 22.244	111º 17.474	631	366; Pope Glacier	erratic boulder	granite
TR3	R5.404.2	Turtle Rock, south-facing slope	75º 22.264	111º 17.379	629	366; Pope Glacier	erratic boulder	granite
HB1	R5.405.2	Hunt Bluff, Bear Peninsula	74º 34.746	111º 53.205	470	57; Dotson Ice Shelf	bedrock	granite
MM1	R5.406.2	Mount Manthe, Hudson Mountains	74º 46.647	099º 22.033	491	300; west of Mt Manthe	erratic boulder	granite
MM2	R5.406.6	Mount Manthe, Hudson Mountains	74º 46.558	099º 21.570	480	300; west of Mt Manthe	erratic boulder	granite
ISL1	R5.407.1	Island, ~1.5km west of Canisteo Peninsula	73º 49.380	102º 56.471	8	N/A	erratic boulder	granitoid

$ British Antarctic Survey collection number.

Table DR2: Analytical information

Sample	BAS#	mass quartz (g)	mass Be carrier (mg)	Al conc.$ (ppm)	$^{10}Be/^{9}Be$	$^{10}Be/^{9}Be$ error	$^{26}Al/^{27}Al$	$^{26}Al/^{27}Al$ error
TR1	R5.403.1	10.1	0.2534	-	1.091E-13	5.322E-15	-	-
TR2	R5.404.1	25.0	0.2527	-	1.996E-13	1.573E-14	-	-
TR3	R5.404.2	8.1	0.2511	-	1.144E-13	5.667E-15	-	-
HB1	R5.405.2	33.6	0.2541	134.2	2.135E-12	4.931E-14	2.004E-12	4.750E-14
MM1	R5.406.2	19.4	0.2539	-	1.022E-13	4.728E-15	-	-
MM2	R5.406.6	40.2	0.2485	-	1.194E-13	4.413E-15	-	-
ISL1	R5.407.1	87.8	0.3578	-	5.602E-14	2.583E-15	-	-

$ Al concentration was measured by ICP-MS at the University of Edinburgh

DR2008056

Table DR3: ^{10}Be and ^{26}Al exposure ages

Sample	BAS#	Elevation (m a.s.l.)	^{10}Be conc. (at g^{-1})	1σ error (at g^{-1})	^{26}Al conc. (at g^{-1})	1σ error (at g^{-1})	Sample thickness (cm)	Shielding correction	^{10}Be prod. rate (at g^{-1} yr^{-1})	1σ error (at g^{-1} yr^{-1})	^{10}Be age (ka)	1σ error (ka)	^{26}Al age (ka)	1σ error (ka)	^{26}Al/^{10}Be	1σ error
TR1	R5.403.1	700	172528	9249	-	-	5	0.9907	11.9723	0.7407	14.5	1.2	-	-	-	-
TR2	R5.404.1	631	130282	10657	-	-	5	0.9854	11.1783	0.6953	11.7	1.2	-	-	-	-
TR3	R5.404.2	629	223516	12089	-	-	4	0.9942	11.3494	0.6940	19.8	1.6	-	-	-	-
HB1	R5.405.2	470	1074789	24913	5984116	142390	5	0.9993	9.7481	0.5979	113.2	7.4	106.2	7.2	5.57	0.18
MM1	R5.406.2	491	81273	4500	-	-	6	0.9988	9.8584	0.6099	8.3	0.7	-	-	-	-
MM2	R5.406.6	480	46602	1911	-	-	4	0.9960	9.8894	0.6036	4.7	0.3	-	-	-	-
ISL1	R5.407.1	8	13482	799	-	-	4	0.9999	6.1516	0.3740	2.2	0.2	-	-	-	-

DATA REPOSITORY

APPENDIX DR1

We applied the technique of surface exposure dating, using cosmogenic ^{10}Be and ^{26}Al, to determine deglaciation ages. Cosmogenic ^{10}Be and ^{26}Al accumulate within quartz-bearing rocks as long as they are exposed to cosmic radiation (Gosse & Phillips, 2001). During glacial periods, several metres of ice overlies the rocks and stops penetration of cosmic rays, therefore halting production of cosmogenic nuclides. With the subsequent onset of deglaciation, the retreating ice deposits debris (e.g. erratic boulders) carried within it. These are exposed to cosmic radiation and accumulation of ^{10}Be and ^{26}Al begins. The abundance of these nuclides is directly correlated with the duration of exposure, and can be measured to give an exposure age. Measuring two nuclides with different half-lives (such as ^{10}Be and ^{26}Al) in the same sample may reveal complex exposure histories (Bierman et al., 1999).

Sample Preparation and Analysis

Details of our samples and sample sites are given in Table DR1. Pure quartz (between 8 and 88 g per sample; Table DR2) was extracted from crushed rock samples following the procedures of Kohl & Nishiizumi (1992) and Bierman et al. (2002). The quartz separates were dissolved in concentrated hydrofluoric acid and spiked with 240-360 µg of commercially prepared Scharlab ^{9}Be carrier (Table DR2) from a 1000 ± 5 ppm Be standard. We performed perchloric acid fumes and anion exchange chromatography to remove Fe. Be and Al were then extracted using cation exchange chromatography. Hydroxides of Be and Al were precipitated from solution by adjusting the pH; these were then fired and mixed with Nb and Ag, respectively, before packing into targets.

Samples were measured by accelerator mass spectrometry (AMS) at the Scottish Universities Environmental Research Centre (SUERC) in East Kilbride, UK. The measurements were normalised to the NIST SRM 4325 standard, which has a $^{10}Be/^{9}Be$ ratio of 3.0×10^{-11}. Measured $^{10}Be/^{9}Be$ ratios (Table DR2) were corrected by laboratory blanks, which we processed in tandem with the samples; these were spiked with ~ 200 µg ^{27}Al Spectrosol carrier. The measured $^{10}Be/^{9}Be$ ratios of these blanks were 6.53×10^{-15} and 9.43×10^{-15}. Our Al blank yielded a near-zero beam current, probably because the sample fell out of the cathode before measurement. We therefore used an Edinburgh University lab procedural blank (with a $^{26}Al/^{27}Al$ ratio of 5.99×10^{-15}) for correction of the measured sample $^{26}Al/^{27}Al$ ratio.

Exposure Age Calculations

The ^{10}Be and ^{26}Al concentrations and parameters used in our exposure age calculations are given in Table DR3. For calculating exposure ages we used the sea level, high latitude production rates of 5.1 ± 0.3 at g^{-1} yr^{-1} for ^{10}Be and 31.1 ± 1.9 at g^{-1} yr^{-1} for ^{26}Al (Lal, 1991), scaled to the altitude and latitude for each sample site (Stone, 2000). This scaling is necessary to account for the lower atmospheric pressure over Antarctica. We used decay constants of 4.62×10^{-7} yr^{-1} for ^{10}Be and 9.83×10^{-7} yr^{-1} for ^{26}Al (Nishiizumi, 2002; 2004), and included corrections for sample thickness, geographic shielding and topographic shielding. The last of these was calculated using the online geometric shielding calculator (found at http://hess.ess.washington.edu/math/general/skyline_input.php) written by Greg

Balco, following Nishiizumi et al. (1989). We assumed a zero erosion rate (since we do not have independent data to estimate erosion rates), a sample density of 2.65 g cm^{-3}, and an attenuation length of 160 g cm^{-2}. Errors given in Table DR3 for our exposure ages are 1σ and were calculated by combining errors associated with production rate and measured nuclide concentrations (i.e. analytical error). They do not include estimates of error on external parameters such as altitude, topographic shielding, etc..

References

Bierman, P.R., Marsella, K.A., Patterson, C., Davis, P.T., and Caffee, M., 1999, Mid-Pleistocene cosmogenic minimum-age limits for pre-Wisconsinan glacial surfaces in southwestern Minnesota and southern Baffin Island: a multiple nuclide approach: Geomorphology, v. 27, p. 25-39.

Bierman, P.R., Caffee, M.W., Thompson Davis, P., Marsella, K., Pavich, M., Colgan, P., Mickelson, D., Larsen, J., 2002, Rates and Timing of Earth Surface Processes From *In Situ*-Produced Cosmogenic Be-10, *in* Grew, E.S., ed., Beryllium: Mineralogy, Petrology, and Geochemistry: Reviews in Mineralogy & Geochemistry, v. 50, p.147-205.

Gosse, J.C., and Phillips, F.M., 2001, Terrestrial in situ cosmogenic nuclides: theory and application: Quaternary Science Reviews, v. 20, p. 1475-1560.

Kohl, C.P., and Nishiizumi, K., 1992, Chemical isolation of quartz for measurement of in situ-produced cosmogenic nuclides: Geochimica et Cosmochimica Acta, v. 56, p. 3586-3587.

Lal, D., 1991, Cosmic ray labeling of erosion surfaces: *in situ* nuclide production rates and erosion models: Earth & Planetary Science Letters, v. 104 (2-4), p. 424-439.

Nishiizumi, K., Kohl, C.P., Arnold, J.R., Winterer, E.L., Lal, D., Klein, J., and Middleton, R., 1989, Cosmic ray production rates of ^{26}Al and ^{10}Be in quartz from glacially polished rocks: Journal of Geophysical Research, v. 94 (B12), p.17907-17915.

Nishiizumi, K., 2002, ^{10}Be, ^{26}Al, ^{36}Cl, and ^{41}Ca AMS standards: Abstract 016-1, 9th Conference on Accelerator Mass Spectrometry, p.130.

Nishiizumi, K., 2004, Preparation of ^{26}Al AMS standards: Nuclear Instruments and Methods in Physics Research B, v. 223-224, p. 388-392.

Stone, J.O., 2000, Air pressure and cosmogenic isotope production: Journal of Geophysical Research, v. 105, p. 23753-23759.